KEITHLEY INSTRUMENTS

INSTRUCTION MANUAL

MODELS 120, 120R

WIDEBAND VOLTMETERS

SECTION 1. GENERAL DESCRIPTION

1-1. DESCRIPTION.

a. The Model 120 Wideband Voltmeter measures and amplifies signals from 10 cps to 100 megacycles. It has 12 ranges, from one millivolt to 300 volts full scale. The instrument is peak-reading and calibrated in rms for all voltage ranges. A decibel scale is also provided. Overall accuracy is within 2% of full scale for all measurements between 20 cps and 50 megacycles. Input impedance is one megohm shunted by 20 picofarads.

b. For a given full-scale input on any range, the output supplies 100 millivolts ac into a 50-ohm load, or 200 millivolts ac into an open circuit. On the most sensitive range, the maximum input noise is below 70 microvolts rms. The rise time of the amplifier is less than six nanoseconds.

c. The Model 120 is a hybrid instrument, utilizing both solid state devices and vacuum tubes. The amplifiers employ ultra-high-frequency transistors to achieve a wide bandwidth. All supporting circuits complement the broad bandwidth of the amplifiers.

1-2. APPLICATIONS.

a. When used with rf receivers, radar and other communication equipment, the Model 120 can make measurements in both the low and high-frequency circuits. Its great bandspread is also useful in slotted line measurements, antenna design studies and magnetic resonance experiments. The use of a single instrument simplifies measurement and increases reliability of the readings.

b. Voltages from 70 microvolts to 300 volts can be measured with little high-frequency circuit loading or varactor effects. This sensitivity, combined with the wide bandwidth of the instrument, permits its use as a null detector for rf bridges, in studies of wideband noise, and in oscillator and transmitter circuit applications. Probes and accessories are available to further extend the applications suitable for the Model 120. (Refer to Section 5.)

c. The accuracy and high input impedance of the Model 120 make it suitable for measurements of transistor gains, and attenuator and filter losses.

d. The Model 120 can be used as a preamplifier for oscilloscopes because of its sensitivity, wide bandwidth and extremely low noise. The rise time of less than six nanoseconds on all ranges is useful in such pulse counting applications as Geiger and scintillation measurements.

1-3. DIFFERENCES BETWEEN THE MODEL 120 AND THE MODEL 120R. The Model 120R is the rack-mounted version of the Model 120 Wideband Voltmeter. (Refer to Figures 1 and 2.) The only difference in specifications is for the dimensions and the weight. The operating and maintenance procedures, the parts list and the schematic diagrams contained in this Manual apply to both models.

1-4. SPECIFICATIONS.

VOLTMETER CHARACTERISTICS

FREQUENCY RANGE: 10 cps to 100 megacycles.

ACCURACY: ± 2% of full scale, 20 cps to 50 megacycles;
± 10% of full scale, 15 cps to 60 megacycles;
- 3 db, 10 cps to 100 megacycles;
Meter Tracking: Meter tracking error may contribute an additional ±1/2% of full scale error to the accuracy specification.

VOLTAGE RANGE: Full-scale readings of one millivolt to 300 volts in 1x and 3.16x steps over 12 ranges.

INPUT NOISE: 70 microvolts rms, maximum.

METER SCALES: Two peak-reading approximately linear scales, 0 to 3 and 0 to 10, calibrated in rms of sine wave. Db scale calibrated from 0 to 10 db.

CALIBRATION VOLTAGES: 10-millivolt and 10-volt square waves at 200 cps.

AMPLIFIER CHARACTERISTICS

RISE TIME: Six nanoseconds, maximum.

OUTPUT VOLTAGE: Unterminated, 200 millivolts ac on all ranges.

MAXIMUM GAIN: Unterminated, approximately 200.

OUTPUT IMPEDANCE: 50 ohms.

GENERAL CHARACTERISTICS

INPUT IMPEDANCE: One megohm shunted by 20 picofarads.

STABILITY: Variations on the 1-millivolt range are within 0.5% for line voltage changes between 105 and 125 volts; on higher ranges, variations are less.

CONNECTORS: Input and Output: Teflon-insulated uhf-type receptacles. Ground binding posts.

TUBE COMPLEMENT: One 6AL5, three 7586

TRANSISTOR COMPLEMENT: Three SM492, five 2N1183, four 2N1381, one 2N1535, five SM1294.

POWER: 105 to 125 volts or 210 to 250 volts, 50 to 400 cps, 40 watts.

ACCESSORIES SUPPLIED: Mating uhf-type plugs; binding post adapter.

DIMENSIONS: Model 120: 11-1/2 inches high x 7-1/4 inches wide x 13-3/4 inches deep.
Model 120R: 5-1/4 inches high x 19 inches wide x 13-1/2 inches deep.

NET WEIGHT: Model 120: 17 pounds.
Model 120R: 17-1/2 pounds.

1-5. ACCESSORIES

a. The Model 120 can be used with three probes, which increase the input impedance of the voltmeter and make many measurements more convenient. Descriptions, specifications and operating instructions for the probes are given in Section 5. In general, using the probes limits the voltmeter's high frequency response to 50 megacycles.

b. Model 1205 Accessory Kit contains adapters, cables, a filter and a termination for use with the Model 120. The kit is described in paragraph 5-6.

1-6. EQUIPMENT SHIPPED. The Model 120 Wideband Voltmeter is factory-calibrated and is shipped with all components in place. The shipping carton contains the Instruction Manual, two Teflon-insulated uhf-type plugs and a binding post adapter. The Model 120R shipping carton also contains a pair of angles which screw on the instrument for use in rack mounting.

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SECTION 2. OPERATION.

2-1. FRONT PANEL CONTROLS AND TERMINALS. (See Figure 3.)

a. POWER SWITCH. The Power switch is a toggle switch which turns the Model 120 on.

b. RANGE SWITCH. The Range switch selects one of the 12 ranges in 1x and 3.16x steps from one millivolt to 300 volts full scale. The reading is made directly from the meter for the range being used.

c. ZERO CONTROL. The ZERO potentiometer adjusts the meter to zero for no input signal. This control should be used on the 300-volt range.

d. PILOT LIGHT. The green pilot light is in series with the Nuvistor tube, so the instrument will not operate if the light is out.

e. PROBE CONNECTOR. The PROBE receptacle is the power outlet for the Model 1201 Cathode Follower Probe. It provides -12 volts dc filament power for the vacuum tube in the probe.

f. INPUT. The INPUT is a uhf-type receptacle. The ground post, G, is connected to the chassis.

2-2. REAR PANEL CONTROLS AND TERMINALS. (See Figures 4 and 5.)

a. POWER CORD. The Model 120 is for a 105-125 volt, 50-400 cps line source, unless otherwise specified on the rear panel. A 3-wire power cord is used.

b. PROBE CALIBRATE CONTROL. This control, marked PROBE CAL, compensates for the input loss in the Model 1201 Cathode Follower Probe circuit. The control adjusts the meter only when the probe is connected; it will not affect the calibration of the meter when the Model 120 is used without a probe.

c. OUTPUT. The uhf-type OUTPUT receptacle supplies 200 millivolts ac at a full-scale meter reading into an open circuit on all ranges.

d. CALIBRATION SIGNAL. The calibration signal, a 200-cps square wave, is calibrated to furnish a full-scale deflection on the 10-millivolt and 10-volt ranges.

e. FUSE. For 105-125 volt operation, the Model 120 uses a 0.75 ampere, 3 AG fuse; for 210-250 volt operation, the Model 120 uses a 0.38 ampere, 3 AG fuse. The fuse is removed by unscrewing the cap and pulling out the fuse holder.

NOTE

Controls marked on the bottom panel are adjusted only for high-frequency calibration, as described in paragraph 4-8.

2-3. VOLTMETER OPERATION.

a. Connect the power cord to a 105-125 volt, 50-400 cps source, unless the Model 120 rear panel is marked for 210-250 volt operation. Turn the power switch to ON and allow the instrument to warm up for 15 minutes. Set the Range switch to the 300-volt range and adjust the meter to zero with the ZERO control.

b. Connect the signal source to the INPUT receptable. Cabling is very important in measuring high-frequency signals; refer to paragraph 2-11 for suggestions to improve hookups. Switch the Range switch down to the most sensitive range for the input signal.

c. When using the 1- and 3-millivolt ranges, the noise inherent in the Model 120 will affect readings. Maximum input noise is 70 microvolts, which is present as an upscale deflection on the meter. This amount should be subtracted from the meter reading for these ranges. Readings below will not be within the instrument's specified accuracy.

2-4. DECIBEL MEASUREMENTS. The decibel scale of the Model 120 allows the voltage ratio to be measured directly in decibels. The scale can be used over all 12 ranges. The ratio between two voltages in decibels is given by

$$(-V_1 + V_2 \pm 10n) \text{ db}$$

where V_1 is the decibel reading of the first voltage;
V_2 is the decibel reading of the second voltage;
n is the number of ranges on the instrument between the two readings. The number is positive if the ranges increase from the first to the second voltage, and it is negative if the ranges decrease.

Example: When the Range switch is on the 1-volt range, a reading of 4 db is obtained. When the Range switch is set three ranges higher on the 30-volt range, a reading of 3.2 is obtained. The ratio between the two voltages is

(-4 + 3.2 + 10x3) db or 29.2 db

DB	VOLTAGE RATIO	POWER RATIO
0	1.00	1.00
0.5	1.06	1.12
1.0	1.12	1.26
1.5	1.19	1.41
2.0	1.26	1.58
3.0	1.41	2.00
4.0	1.58	2.51
5.0	1.78	3.16
6.0	2.00	3.98
7.0	2.24	5.01
8.0	2.51	6.31
9.0	2.82	7.94
10	3.16	10.0
15	5.62	31.6
20	10	100

TABLE 1. Decibel Relationships to Voltage and Power Ratios. The Voltage Ratio is the value in volts if the reference level is one volt. The Power Ratio gives the value in milliwatts if the reference level is one milliwatt.

2-5. AMPLIFIER OPERATION.

a. The Model 120 can be used as a preamplifier or as an attenuator for other instruments without disturbing the operation of the meter. A uhf-type receptacle is on the rear panel. The amplifier will supply 200 millivolts ac unterminated for a full-scale meter reading on all 12 ranges.

b. Signal transmission and connection techniques for amplifier operations are similar to those for use as a wideband voltmeter. Refer to paragraph 2-11.

c. Connect the Model 120 and other associated equipment, such as an oscilloscope, on the same power line to avoid ac ground loops. Otherwise, the output signal from the Model 120 will tend to be modulated by the ground loops.

2-6. USE OF CALIBRATION SIGNAL.

a. To quickly check the Model 120, the calibration signal available on the back panel may be used. These signals may be used to determine if the instrument is operating properly; however, this check is not to be substituted for the standard calibration of the Model 120 given in Section 4.

b. Set the Range switch to 10 millivolts and zero the meter. Connect the INPUT to the 10 MV calibration signal. Use a shielded coaxial cable for connecting the input and the calibration signal. The meter should read full scale, 10 millivolts. A similar check can be made on the 10-volt range using the 10 V calibration signal.

c. All voltage ranges are effectively checked using the two calibration signals. Note the signals are regulated to furnish a voltage which reads 10 millivolts or 10 volts only when read by the Model 120.

2-7. ACCURACY CONSIDERATIONS. In high-frequency measurements, other considerations affect the accuracy of a measurement beside the voltmeter. The voltmeter can only read the signal received at its input terminal; therefore, it is important that this signal be the same as that of the source. The following paragraphs list points to consider during a measurement to increase the accuracy of the reading. Since it would take a considerable volume to carefully examine each point, these paragraphs should serve as a checklist. Points considered are meter reading, loading effects, ground loops, cabling, signal pickup and stray fields.

2-8. METER READING. The Model 120 is essentially a peak-reading instrument, except for the first 10% of the scale, calibrated to read the effective rms value of a sine wave. Waves which contain a large amount of harmonics will introduce errors, since the Model 120 cannot discriminate between sine wave peaks and harmonic peaks. Table 2 indicates the deviations harmonics will cause from a true rms value.

Input Voltage	True rms Value	Approximate Per Cent of Error
Fundamental of 100	100	0%
Fundamental + 10% 2nd harmonic	100.5	0%
Fundamental + 20% 2nd harmonic	102	2%
Fundamental + 50% 2nd harmonic	112	10%
Fundamental + 10% 3rd harmonic	100.5	4%
Fundamental + 20% 3rd harmonic	102	6%
Fundamental + 50% 3rd harmonic	112	20%

TABLE 2. Effect of Harmonics on Peak-Reading Meters.

2-9. LOADING EFFECTS.

a. The input impedance of the Model 120 must be high relative to the impedance of the source. If the two approach each other in value, a significant portion of the source voltage is dropped across its own internal impedance. In general, the voltage read by the meter is

$$E_m = \frac{Z_m}{Z_o + Z_m} E_o \qquad \text{Eq.1}$$

where E_m is the voltage read by the Model 120;
E_o is the source voltage;
Z_m is the Model 120 input impedance, one megohm, 20 picofarads;
Z_o is the source impedance.

At low frequencies, the source impedance should be less than 10 kilohms to avoid an error in reading of less than 1%. For higher source impedances, the probes described in Section 5 will minimize circuit loading effects.

Frequency	Model 120 Input Impedance
10 cps	10^6 ohms
100 cps	10^6 ohms
1 kc	9.5×10^5 ohms
10 kc	6.2×10^5 ohms
100 kc	7.95×10^4 ohms
1 Mc	7.95×10^3 ohms
10 Mc	7.95×10^2 ohms
50 Mc	1.59×10^2 ohms
100 Mc	79.5 ohms

TABLE 3. Model 120 Input Impedance at Various Frequencies.

b. As frequencies increase, the Model 120 input capacitive reactance decreases. Therefore, to minimize circuit loading of the test setup, every effort must be made to minimize added input capacitance or to reduce the source impedance. Input capacity will decrease by using cables as short as possible or by using one of several accessory probes available. The effective source impedance may also be reduced by using a terminated coaxial system, usually terminated at 50 ohms.

2-10. GROUND LOOPS. A common source of errors when making low-level measurements is ground loops. This is a current of signal — line or other frequency— flowing in a ground lead impedance, which results in a voltage in addition to the desired signal voltage appearing at the input terminals of the voltmeter. Although the origin and mechanism of ground loops are difficult to explain and trace, their effects can be reduced in several ways.

a. Eliminate unnecessary grounds by using a 3 to 2 prong adapter to lift the instrument case from power system grounds.

b. Use a low capacitive, high insulation-resistive isolation transformer between the power line and the voltmeter.

c. Make all ground lead impedances as low as possible.

d. Employ, as far as possible, only coaxial connecting leads in the signal circuits to the voltmeter input terminals.

2-11. CABLING CONSIDERATIONS.

a. In high-frequency applications, proper transmission lines and connections become an important part of the system. If transmission lines or connections are improper, reflections, standing waves or undue loading on the source may cause errors in the measurement. If it is necessary to use other than 50-ohm cables, suitable matching devices should be used to couple between cables or

inputs having different characteristic impedances. Keep all transmission lines as short as practical to minimize cable losses.

b. Reflections and standing waves can introduce significant errors into a measurement setup, particularly if the measured frequency is above a few megacycles. As a wave travels down a transmission line, it generates a reflection each time it encounters a mismatch or impedance difference. The reflection travels back along the line to the signal source where it either adds to or subtracts from the input signal at that instant. The amplitude and polarity of the reflection depend upon the nature of the mismatch which caused the reflection. Standing waves may also be introduced if the transmission line is of appreciable length compared to the wave length being measured. In general, to reduce inaccuracies due to reflections and standing waves, use a terminated coaxial system. Special care should be given to proper matching and cable length.

2-12. RESONANCE. Inaccuracies may be introduced by resonance at the input of the Model 120 due to shunt capacitance and series inductance. The occurrence of resonance becomes more likely as series inductance is increased (usually cable inductance) and measured frequencies become higher. To minimize the occurrence of resonance, use connections and cabling of minimum inductance. A special case may occur when the Series 1200 Accessory Probes are used. Avoid lengthening the ground cable of the probes. At very high frequencies, it may be necessary to replace the probe ground cable with a cable of less inductance, (decrease the length or increase the other physical dimensions). Usually, the resonant point of a terminated coaxial system is at a frequency too high to affect the Model 120's accuracy.

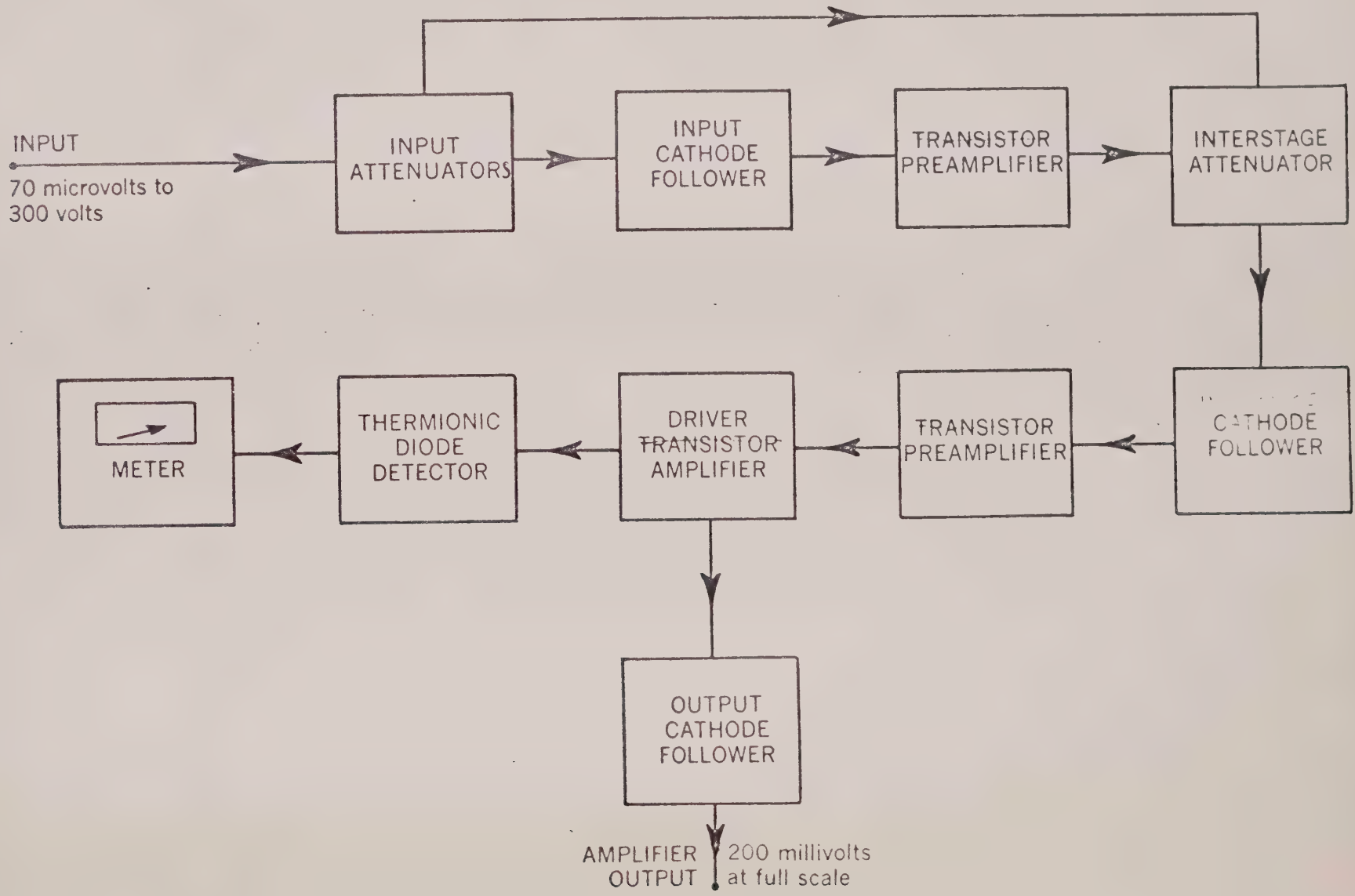
2-13. SIGNAL PICKUP. Unwanted signals, such as 60 cps, may be picked up directly by the Model 120. This source of inaccuracy becomes more significant as measurements become more sensitive and source impedances become higher. To reduce the errors, use appropriate electrostatic or magnetic shielding. The type of shielding used and its physical configuration will vary with individual measurement circumstances.

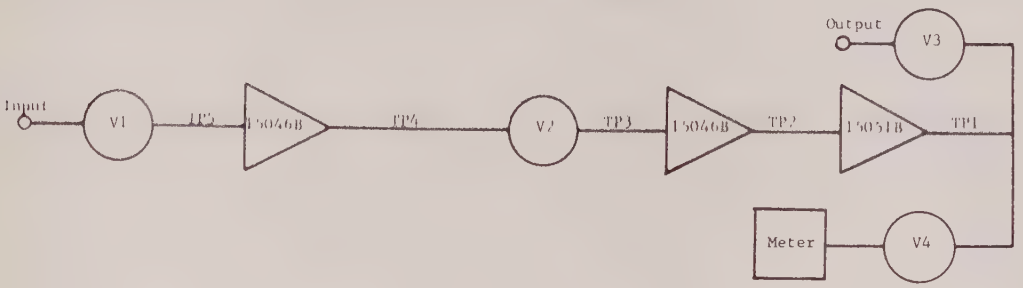
2-14. STRAY FIELDS. Stray fields can induce unwanted emfs in the test system. The inaccuracies due to these fields become more significant as measurements become more sensitive. Induced emfs may be reduced by using coaxial cable having minimum loop area and by using cables of minimum length.

SECTION 3. CIRCUIT DESCRIPTION

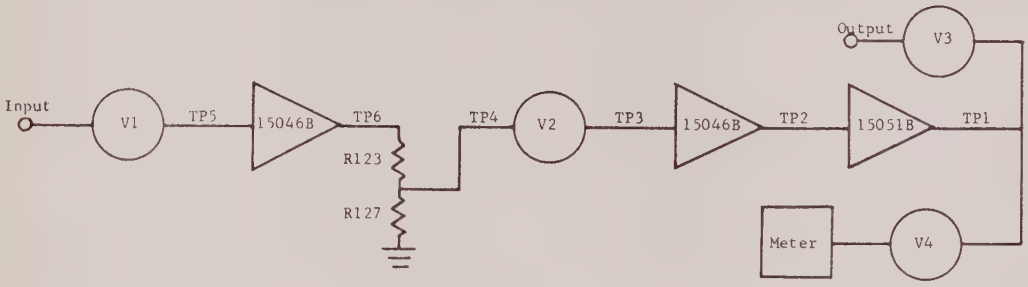
3-1. GENERAL. The Model 120 Wideband Voltmeter amplifies and then rectifies an input signal to drive a dc meter. The instrument acquires its wide bandwidth by using ultra-high-frequency transistors in the amplifiers. The block diagram (Figure 6) illustrates the general operation of the circuits. The input signal is transmitted through the attenuator circuits and the cathode follower to the wideband transistor amplifiers. After amplification, the signal is detected by a thermionic diode which drives the meter. An output from the driver amplifier provides 200 millivolts ac on any range for use with oscilloscopes or other instruments. Each amplifier is contained on a plug-in module. The two preamplifiers have identical circuits. The exact circuit varies with range, as described in paragraph 3-2.

FIGURE 6. Model 120 Block Diagram.

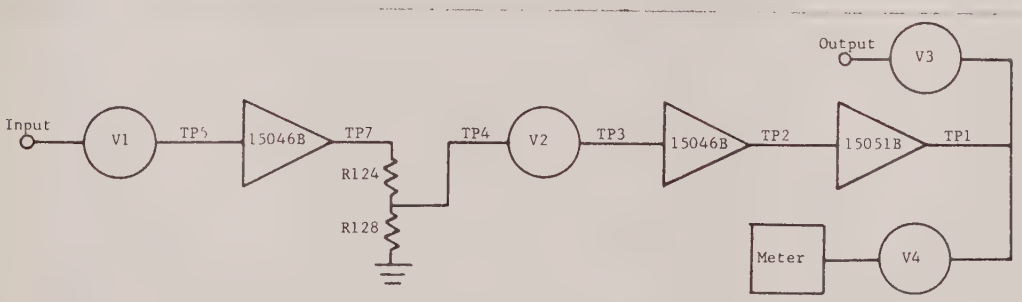

INPUT
70 microvolts to
300 volts
INPUT ATTENUATORS
INPUT CATHODE FOLLOWER
TRANSISTOR PREAMPLIFIER
INTERSTAGE ATTENUATOR
METER
THERMIONIC DIODE DETECTOR
DRIVER TRANSISTOR AMPLIFIER
TRANSISTOR PREAMPLIFIER
CATHODE FOLLOWER
OUTPUT CATHODE FOLLOWER
AMPLIFIER OUTPUT
200 millivolts at full scale



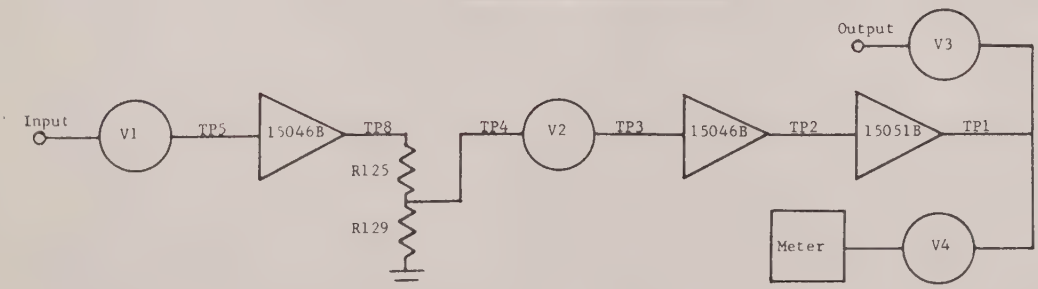
1-Millivolt Range



3-Millivolt Range



10-Millivolt Range



30-Millivolt Range

FIGURE 7 (Sheet 1). Model 120 Circuit by Range.

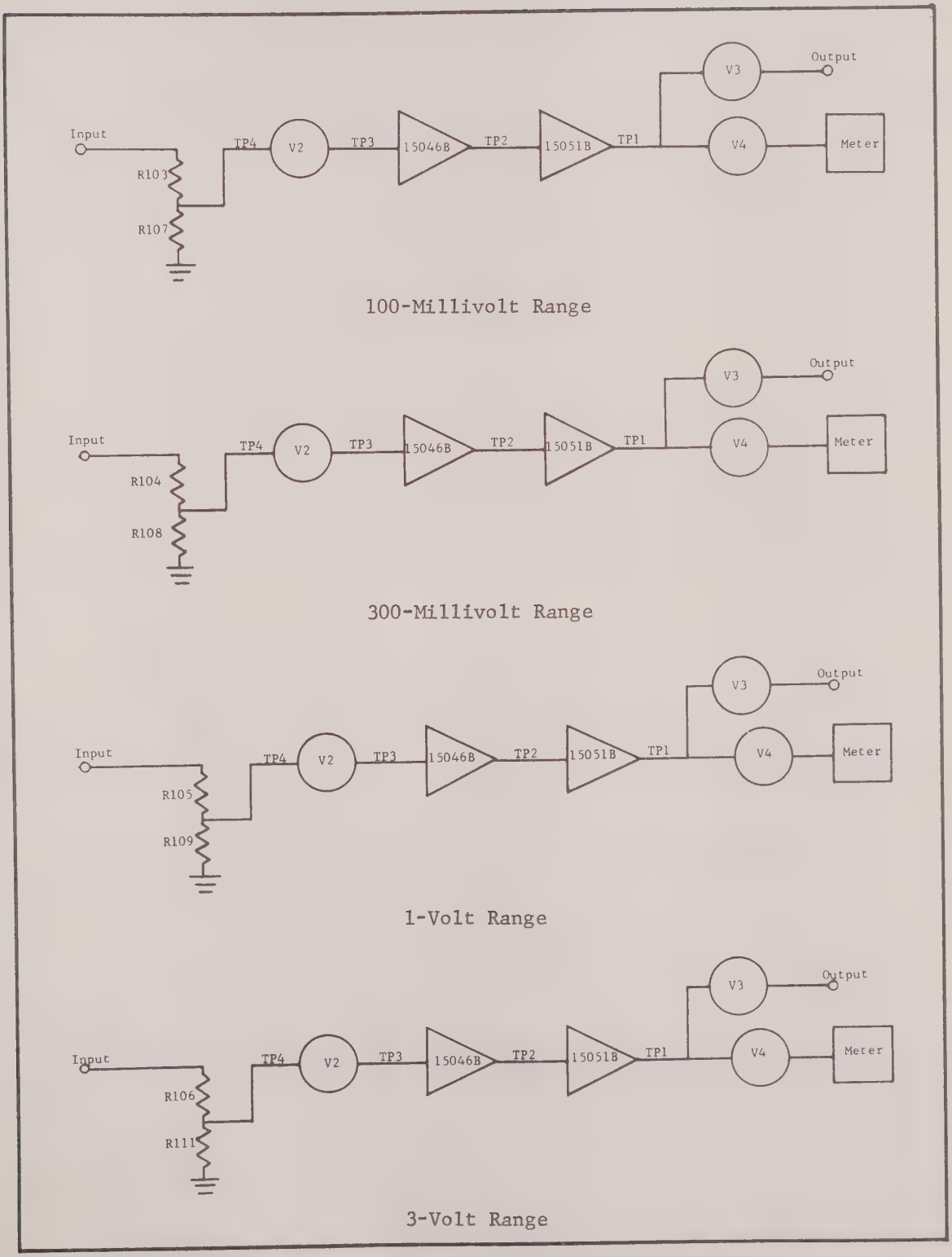


FIGURE 7 (Sheet 2). Model 120 Circuit by Range.

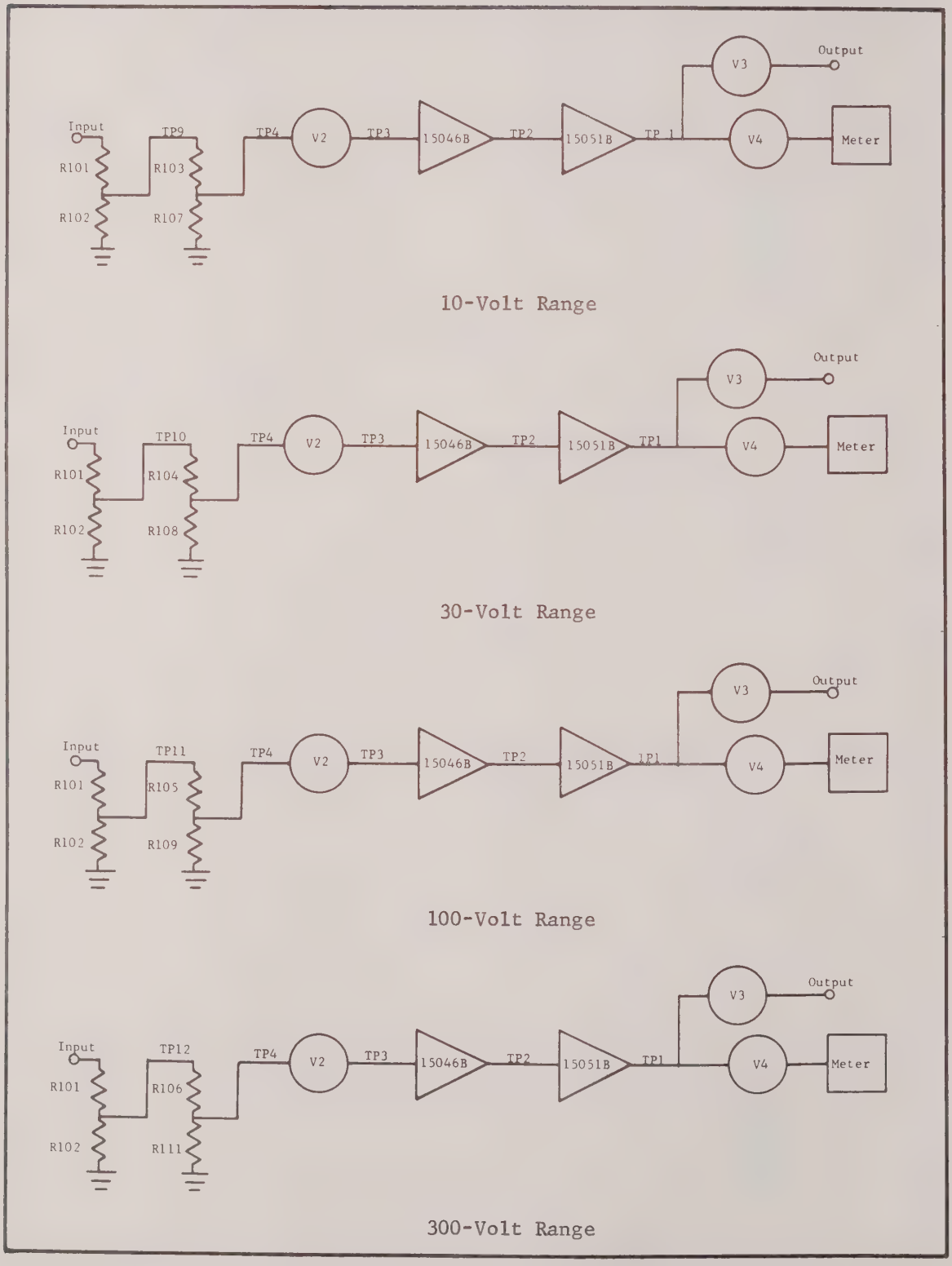


FIGURE 7 (Sheet 3). Model 120 Circuit by Range.

3-2. CIRCUITS BY RANGE. (Refer to schematic 15099E for circuit designations.)

a. The Model 120 is composed of several basic elements: attenuators, cathode followers, amplifiers, metering circuit and power supply. The circuits for each range are designed to provide a 2-volt rms signal at the diode rectifier, V4, for full-scale meter reading. Figure 7 illustrates the circuit through the voltmeter for each of the 12 ranges. Selection of the attenuator, and preamplifiers is done with the Range switch, S1. The driver amplifier, the metering circuit and the power supply are used for all ranges.

b. The 1-millivolt range uses all three amplifiers and no attenuators. If each amplifier, cathode follower and associated wiring are grouped together, the approximate gain for each amplifier is 17, 25.2 and 5, respectively, with a total gain of 2000.

c. The 3-, 10- and 30-millivolt ranges use all of the amplifiers and the low-level attenuator. For these ranges, the input impedance of the voltmeter is determined by the input capacity of the first cathode follower, V1, and the miscellaneous stray capacities in parallel with the 1-megohm grid resistor, R113.

d. On all ranges greater than 30 millivolts, the first preamplifier is not in the circuit, and the medium-level attenuator is inserted before the second preamplifier. Ranges above 3 volts use the high-level and medium-level attenuators.

3-3. ATTENUATORS. (Refer to schematic 15099E for circuit designations.)

a. The input attenuators were designed to maintain a 1-megohm input resistance on all ranges without degrading amplifier response or accuracy. Precision metal-film resistors are used for all attenuators, shunted where necessary by fixed or variable capacitors. The variable capacitors permit an independent adjustment of high-frequency attenuation on each range, thereby, compensating for resistor and wiring variations.

b. The resistors which comprise the high-level attenuator are R101 and R102. The medium-level attenuator consists of resistors R103 through R111. The low-level attenuator consists of resistors R123 to R125 and R129.

3-4. CATHODE FOLLOWERS. Nuvistor tubes were selected for the cathode followers, V1, V2 and V3, to provide high impedance matching and to protect the instrument from excessive input signals. On the four most sensitive ranges, the input signal is directly into V1. On these ranges, the input will withstand overloads of 50 volts rms. Overload protection increases on the other ranges to a maximum of 400 volts rms on the 300-volt range, thus protecting the solid state components within the instrument. The high-impedance tube characteristic insures a stable, passive input, thus avoiding high-frequency resonance between the measuring circuit and the source.

3-5. PREAMPLIFIERS. (Refer to schematic 15098C for circuit designations.)

a. Both preamplifiers are identical, consisting of three stages with dc feedback around each stage. The feedback resistors for each stage are R303 and R304, R310 and R311, R315 and R316. To prevent ac feedback, ac bypass

capacitors C303, C306 and C307 are used.

b. Negative feedback is used around the preamplifier to maintain a constant reduced gain over the entire pass band. Since the gain bandwidth product is the limiting factor for these amplifiers, reducing the gain maintains a flat response over a wider frequency range. Resistor R317 supplies the amplifier output voltage. The feedback circuit back to the input transistor, Q11, is through the voltage divider, resistors R312 and R305. To compensate for high-frequency losses, the gain is increased by bypassing part of the negative feedback with trimmers C304 and C308. The trimmers also compensate for any stray capacitive negative feedback between the input and output of each preamplifier.

c. Resistor R302 provides a small amount of low-frequency coupling between transistors Q11 and Q12 to extend the lower limit of frequency response and to provide low-frequency stability.

d. The gain of the preamplifiers is adjusted through a network containing potentiometers R121 and R128 (schematic 15099E).

3-6. DRIVER AMPLIFIER. (Refer to schematic 15096C for circuit designations.)

a. Since it drives the meter circuit, the driver amplifier is designed to supply two volts rms at full scale. Therefore, the transistors for the driver amplifier are chosen for greater power handling than those used in the preamplifiers.

b. The driver amplifier uses two stages with dc feedback around each stage. The feedback resistors for each stage are R403 and R404, R410 and R411. Capacitors C402 and C406 are used to bypass ac feedback.

c. A negative feedback network, consisting of resistors R402 and R406, is also used around the entire amplifier. Capacitor C403 and resistor R405 provide positive feedback across Q14 to balance the inherent negative feedback due to inter-electrode capacity between the collector and the base of the transistor. This positive feedback is obtained by driving the emitter away from the base and, therefore, increasing the effective applied base input signal.

d. The signal from the driver amplifier is coupled to the metering circuit by capacitor C407.

3-7. METERING CIRCUIT. (Refer to schematic 15099E for circuit designations.)

a. The signal from the driver amplifier is applied to the diode V4. The vacuum diode is a specially designed high-frequency rectifier with very low cathode-to-plate capacity. Since it is a thermionic device, the anode will tend to accumulate a negative charge under no-signal conditions sufficient to give a zero offset. This accumulated negative charge is bucked out by application of a positive voltage from a divider network which includes potentiometer R149, the ZERO adjustment. A filter composed of resistor R151 and capacitor C143 removes the ripple from the rectified signal.

b. A resistor string consisting of R152, R155 and R159 determines the dc meter sensitivity. When the probe is in the circuit, potentiometer R154 adjusts the meter response to compensate for losses in the Model 1201 Cathode Follower Probe. Adjusting R154 does not affect the meter unless the probe is being used.

3-8. POWER SUPPLY. (Refer to schematic 15099E for circuit designations.)

a. The transistor-regulated power supply has line regulation of better than 0.001% and long-term dc stability within 0.1%. Power dissipation and heating effects are minimized by the solid state design. The -12 volt dc output of the transistor regulator supplies the filaments of all thermionic devices used in the instrument. Gain changes with line voltage are thus minimized, even at the highest sensitivities. The power supply also furnishes -26 volts and +75 volts.

b. Unregulated voltage from transformer T1 is rectified by diodes D102 and D103 and then is filtered. The voltage is applied to the series regulator transistor, Q1. To obtain the stable -12 volt supply, the output of Q1 is sampled by the resistor string R210, R225 and R231, and is compared to the zener reference diode, D110. If a voltage difference exists, it is amplified by transistors Q5 and Q6, operating as a differential voltage amplifier. A dc amplifier Q4 further amplifies the error signal. Transistors Q3 and Q2 are cascaded current amplifiers with capacitor C204 serving as an ac bypass. The amplified difference signal is then applied to the base of the series regulator transistor Q1. In this way, a stable voltage is furnished for the filaments. Also, since the pilot lamp, DS-1, is in series with the filament of Nuvistor tube V1, the voltmeter will not operate if the lamp is off.

c. An ac to dc converter is used to supply -26 volts and +75 volts from the -12 volt supply. Transistors Q7 and Q8 form a switching network to supply an interrupted dc voltage to transformer T2. An extra winding from the transformer supplies feedback to the network to sustain switching action; resistor R212 determines the magnitude of the feedback. A filter, composed of resistor R221 and capacitor C207, prevents the introduction of spikes caused by the switching network into the -12 volt supply. A portion of the voltage from the switching network is supplied to the divider network, R222, R223 and R224, to obtain the 10-millivolt and the 10-volt calibration signals.

d. The +75 volt output is derived from the secondary of transformer T2 after it is rectified and filtered. Rectifiers D106 and D107 apply a voltage to a filtering network containing a transistor current amplifier, Q9. The base circuit of the transistor contains a capacitor filter network.

e. The -26 volt output is derived from transformer T2 through a similar circuit. Transistor Q10 is the current amplifier.

CALIBRATION PROCEDURE

MODEL 120/R WIDEBAND VOLTMETER

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120.6	Calibration Adjustments
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120.8	Trouble-Shooting Hints

120.1 Test Equipment

120.11 General Purpose Test Equipment

Conventional VTVM (RCA Volt - Ohmist)

D. C. Voltmeter (United Systems Z202A)

A. C. VTVM (HP 400 CD)

120.12 Special Purpose Test Equipment

Function Generator (HP - 202A)

Oscilloscope (Tektronix 503 or 561A)

Voltmeter Calibrator (HP 738AR)

Oscillator (HP 200CD)

Oscillator (HP 200SR)

Frequency Response Test Set (HP 739AR)

Constant Amplitude Signal Generator (Tektronix 190B)

Power Amplifier (Boonton 230A)

120.13 Special Test Equipment

10DB & 20DB Attenuators (GR - 874 Type)

50 Ohm Terminations (GR - 874 & Bird 80-A)

Transfer Standard (Fluke 540A)

120.3 Preliminary Calibration Procedure

120.32 Power Supply

120.321 Connect Model 120 less plug-in modules to 110v/60 cps. Check 12v supply. If supply is regulating, check +75v and -26v supplies.

120.322 Turn power off, plug in modules and turn power on again. Monitor -12v supply with digital voltmeter. Adjust R231 for -12v ±50 mv DC. Monitor -12v supply with scope. Power supply noise should be less than 8mv peak-to-peak. Check the +75v and -26v supplies. Noise should be less than 5 mv peak-to-peak. Record the peak-to-peak noise on the -12v, +75v and -26v supplies on the unit's history card.

120.323 Line Regulation

Test the -12 volt supply for proper regulation by varying the line voltage from 100 to 140 volts AC. The -12 volts should remain constant ±10 mv DC. Connect the 1201 probe and repeat test.

120.4 Final Calibration (100 mv through 300 volts)

120.41 Gain Calibration

Set the 120 to the 1 volt range. Connect voltmeter calibrator with output at 1 volt ±25% to the 120 input. Adjust R138, 1K trimmer pot located on main chassis, to obtain 2 volts on the plate (pin 7) of the 6AL5. Insure that meter zero is correct. Adjust R159, 12K meter cal pot located on main chassis, to obtain a full-scale reading. Change voltmeter calibrator output to 3 volts ±.25% and check 120 full-scale accuracy on the 3-volt range for 3 volts ±.25%. Change R-112 (4.722K) if necessary to obtain correct accuracy.

120.42 Range Calibration

Check the 100 mv through 300 v ranges on the 120 for full-scale deflection ±.25% using the voltmeter calibrator. Change range resistors if necessary to obtain rated accuracy. Record accuracies obtained on the history card.

120.43 Meter Tracking

Check the 1-volt and 3-volt ranges for proper tracking using the voltmeter calibrator. The meter tracking should be within ±.5% of full scale. Record accuracies obtained on the unit's history card.

120.44 Frequency Response

120.441 Low Frequency

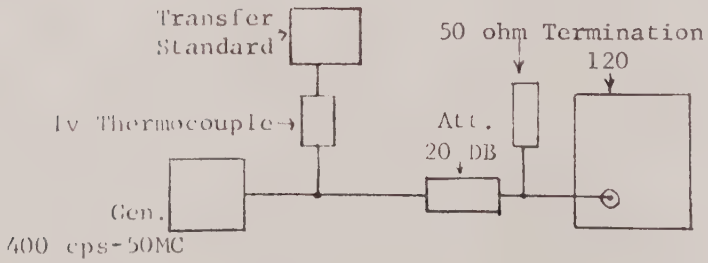
Switch 120 to 100-mv range. Apply 90 mv (rms) at 1000 cps using constant amplitude function generator. Sweep to 20 cps. Adjust R-302, located in middle module, to 90 mv (rms). Sweep from 400 cps to 20 cps and check for a frequency response within $\pm$2%.

Sweep to 15 cps. Frequency response at 15 cps should be within -10%.

For this instrument $\pm$2% is $\pm$2 minor meter divisions, $\pm$5% is $\pm$5 minor meter divisions and -3DB is -30 minor meter divisions.

120.442 High Frequency

120.4421 100 mv Range



Set up test equipment as shown above. Apply 90 mv @ 1000 cps to input of 120. Adjust the constant voltage source to obtain a null on the microvoltmeter.

Increase the sensitivity of the microvoltmeter up to 100 μv full scale. The reference level has been established for a 90% full-scale reading at 400 cps.

Apply a sufficient signal at 10 Mcs to the input of the 120 to obtain a null on the microvoltmeter. Adjust C-105 on the 100-mv attenuator to obtain 90% of full-scale meter reading.

Apply a sufficient signal at 21 Mcs to the input of the 120 to obtain a null on the microvoltmeter. Adjust C-304 on the middle amplifier to obtain 90% of full-scale meter reading.

Apply a sufficient signal at 45 Mcs to the input of the 120 to obtain a null on the microvoltmeter. Adjust C-308 on the middle amplifier to obtain 90% of full-scale meter reading.

Apply a sufficient signal at 50 Mcs to the input of the 120 to obtain a null on the microvoltmeter. Adjust C403 on the third amplifier to obtain 90% of full-scale meter reading. In general, C403 should be adjusted as close to minimum as possible to prevent linearity problems.

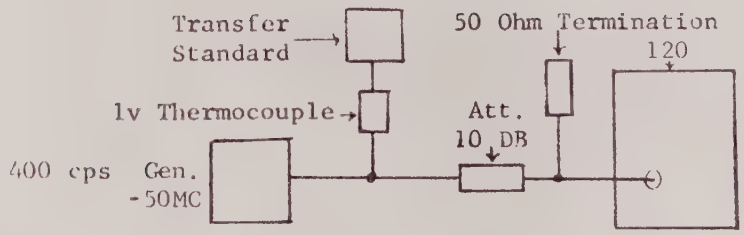
Adjust input signal at 50 Mcs to obtain exactly 9 on the meter. Insert 6 DB pad in series with 20DB pad in test set up. Meter reading should drop to 4.5 on the meter

within 1/2%. If the meter reads high, a linearity problem is present and Q15 must be changed. The above calibration procedure must be repeated.

Because of the inter-action of the controls, it will be necessary to adjust between C-105, C-304, C-308 and C-403 to obtain the proper frequency response. The frequency response must be within ±2% or ±2 minor meter divisions from 400 cps to 50 Mcs.

Since the 100 mv - 300 v amplifier is tuned only once (on the 100-mv range), the frequency response must be as good as possible to insure proper response on the remaining ranges. Typically, the frequency response on the 100 mv range from 10 Mcs to 50 Mcs should be well within 1%.

After the C105, C-304, C-308 and C-403 are tuned for the best possible frequency response, sweep from 400 cps to 50 Mcs to insure frequency response within ±2%. Record critical frequency points on the history card. The 100-mv range is calibrated.

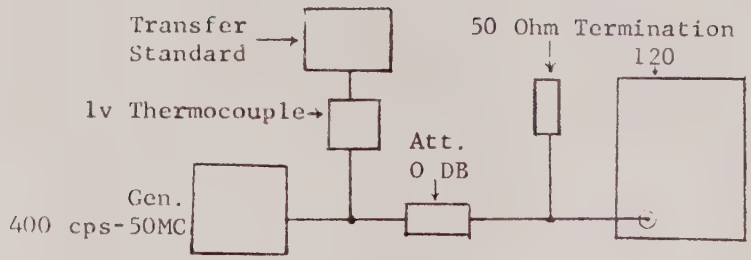


Set up test equipment as shown above. This step is similar to 120.4421, except apply sufficient signal to read 90% of full scale on the 300-mv range at 1000 cps. (Always use 0 - 10 scale for determining frequency response).

After reference level has been established at 1000 cps, adjust C106 to obtain 90% of full scale at 10 Mcs within ±1/2%.

Check frequency response from 400 cps to 10 Mcs to insure response within ±2%, adjusting C106 only if necessary. Check frequency response from 10 Mcs to 50 Mcs at 5 Mc increments to insure response within ±2% to 50 Mcs. Make no adjustments to the amplifier.

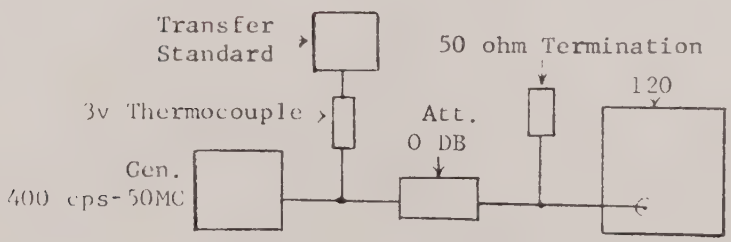
120.4423 1 v Range



Set up test equipment as shown above. After reference level at 90% of full scale has been established at 1000 cps, adjust C107 to obtain 90% of full scale at 10 Mcs within ±1/2%.

Check frequency response from 400 cps to 10 Mcs to insure response within ±2%, adjusting C107 only if necessary. Check frequency response from 10 Mcs to 50 Mcs at 5 Mc increments to insure response within ±2% to 50 Mcs. Make no adjustments to the amplifier.

120.4424 3 volt Range



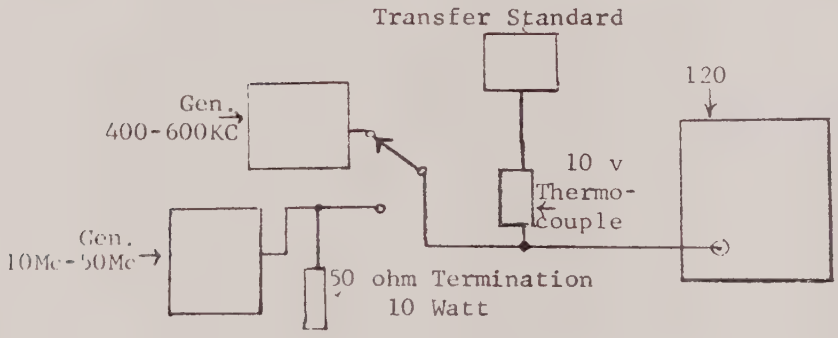
Set up equipment as shown above. After reference level at 90% of full scale has been established

120.4424 (continued)

at 400 cps, adjust C108 to obtain 90% of full scale at 10 Mcs within ±1/2%.

Check frequency response from 400 cps to 10 Mcs to insure response within ±2%, adjusting C108 only if necessary. Check frequency response from 10 Mcs to 50 Mcs at 5 Mc increments to insure response within ±2% to 50 Mcs. Make no adjustments to the amplifier.

120.4425 10 volt Range



Set up test equipment as shown above. After reference level at 90% of full scale has been established at 400 cps, adjust C102 to obtain 90% of full scale at 10 Mcs within ±1/2%.

Check frequency response from 400 cps to 600 Kc to insure response within ±2%, adjusting C102 only if necessary. Check frequency response from 10 Mcs to 50 Mcs at 5 Mcs increments to insure response within ±2% to 50 Mcs. Make no adjustments to the amplifier.

120.5 Final Calibration (1 mv - 30 mv)

120.51 Gain Calibration

Connect voltmeter calibrator output of 10 mv ±.25% to the 120 input. Adjust R-121, 1K pot located on main chassis, to obtain 10 mv full scale on the 10-mv range. Insure that meter zero is correct.

120.52 Noise Check

Switch 120 to 1-mv range. Noise on the meter should be less than 70 μv.

120.53 Range Calibration

Check the 1-mv through 30-mv ranges on the 120 for full scale deflection ±0.25% using the voltmeter calibrator. 1 mv range should read high because of noise. Change range resistors if necessary to obtain rated accuracy. Record accuracies obtained on the history card.

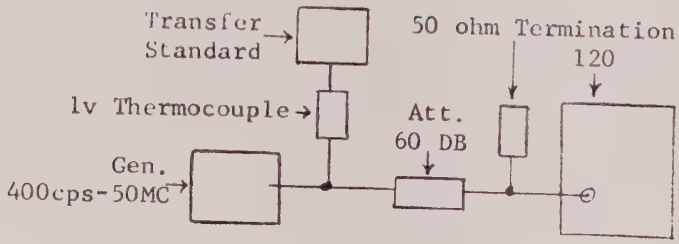
120.54 Frequency Response

120.541 Low Frequency

Switch 120 to 10-mv range. Apply 10 mv (rms) at 400 cps using a constant amplitude function generator. Sweep to 20 cps. Adjust R302, located in front module, to obtain 9 mv (rms). Sweep from 400 cps to 20 cps and check for a frequency response within ±2%. Sweep to 15 cps. Frequency response at 15 cps should be within -10%.

120.5421 High Frequency

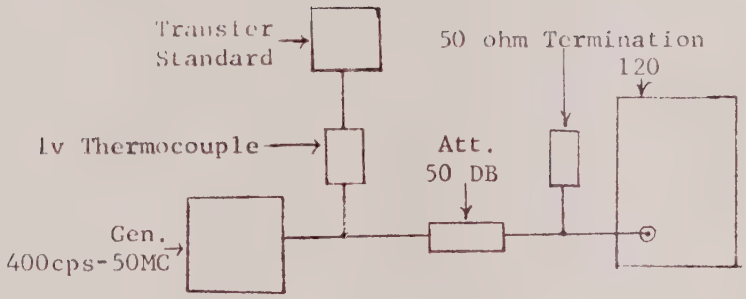
120.5421 1 mv Range



Set up test equipment as shown above. After reference level at 90% of full scale has been established at 400 cps, sweep to 21 Mcs and adjust C304 on the front amplifier to obtain a 90% of full-scale reading within ±2%. Sweep to 50 Mcs and adjust C308 to obtain 90% of full scale reading within 2%. Sweep back and forth between 21 and 50 Mcs, adjusting C304 and C308 respectively to obtain as flat a frequency response as possible. Typical response from 21 to 50 Mcs is within ±1%. Note that this range has no attenuator adjustment.

Since the 1 mv - 30 mv amplifier is tuned only once (on the 1-mv range), the frequency response must be as good as possible to insure proper response on the remaining ranges.

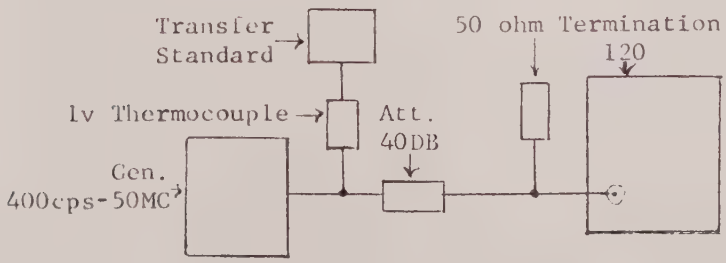
120.5422 3 mv Range



Set up test equipment as shown above. After reference level at 90% of full scale has been established at 400 cps, adjust C118 to obtain 90% of full scale at 10 Mcs within ±1/2%.

Check frequency response from 400 cps to 10 Mcs to insure response within 2%, adjusting C118 only if necessary. Check frequency response from 10 Mcs to 50 Mcs at 5 Mc increments to insure response within ±2% to 50 Mcs. Make no adjustments to the amplifier.

120.5423 10 mv Range

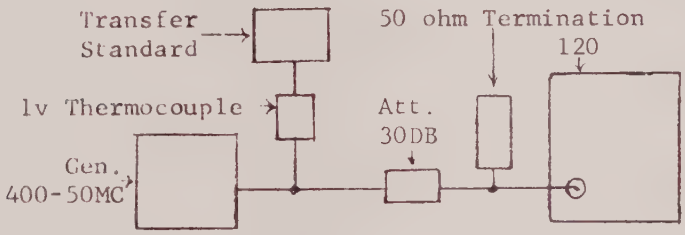


Set up test equipment as shown above. After reference level at 90% of full scale has been established at 400 cps, adjust C119 to obtain 90% of full scale at 10 Mcswithin ±1/2%.

120.5423 (continued)

Check frequency response from 400 cps to 10 Mcs to insure response within ±2%, adjusting C119 only if necessary. Check frequency response from 10 Mcs to 50 Mcs at 5 Mc increments to insure response within ±2% to 50 Mcs. Make no adjustments to the amplifier.

120.5424 30 mv Range



Set up test equipment as shown above. After reference level at 90% of full scale has been established at 400 cps, adjust C120 to obtain 90% of full scale at 10 Mcs within ±1/2%.

Check frequency response from 400 cps to 10 Mcs to insure response within ±2%, adjusting C120 only if necessary. Check frequency response from 10 Mcs to 50 Mcs at 5 Mc increments to insure response within ±2% to 50 Mcs. Make no adjustments to the amplifier.

120.6 Calibration Adjustments

120.61 10 v and 10 mv Calibration Signal

Switch 120 to 10-v range and apply 10 v calibration signal from 120 to the input. Adjust R-228 (20K) for full-scale deflection.

Apply 10-mv calibration signal to input and switch to 10-mv range. Adjust R-229 (2K) for full-scale deflection.

120.62 Probe Calibration

Plug in 1201 test probe. Apply 10-mv calibration signal to probe input and adjust R-159 (2K) for full-scale deflection on the 10-mv range.

120.7 AC Output

Apply 1 v (400 cps) with the 120 on the 1-v range and monitor the AC output. The output should be approximately 200 mv and free from distortion.

Shunt output with 50 ohms. Output voltage should drop in half, indicating an output impedance of 50 ohms.

120.8 Trouble-Shooting Hints

120.81 Power Supply

-12 Volts Not Regulating

a) Zener (D-110) not maintaining 9 ±.5 volts.

120.81 (continued)

b) Zener (D-111) not maintaining 10 ±.5 volts

c) Diode (D-104) open or shorted.

d) Transistor failure.

+75 Volts Not Regulating (-12 Volts OK)

a) Q7 and Q8 not switching.

b) Q9 defective.

c) Switching transformer defective.

-26 Volts Not Regulating (-12 Volts OK)

a) Q7 and Q8 not switching.

b) Q10 defective

c) Switching transformer defective.

120.82 Range Accuracy

a) Range resistors matched improperly.

120.83 Low Frequency Response Poor

120.831 100 mv - 300 v Amplifier

a) R-302 adjusted improperly.

b) C-302 improper value.

c) Q12 High Beta (should have Beta of 40 to 50).

d) V2 not by-passed properly.

120.832 1 mv - 30 mv Amplifier

a) R-302 adjusted improperly.

b) C-302 improper value.

c) Q12 High Beta (should have Beta of 40 to 50).

d) V1 not by-passed properly.

120.84 High Frequency Response Poor

120.841 10 MC Trimmer Cannot Be Adjusted Properly

a) Divider capacitor wrong value.

b) Range resistor poor frequency response.

120.842 Peaking or Dip at 100 KC - 1 MC Region

a) Divider cap out of tolerance.

b) Range resistor frequency response incorrect, causing poor crossover.

120.843 Peaking of Dip at 40-50 MCS on 300 mv - 10 V Range

a) Increase or decrease R-156, R-109, R-111 or R-130 respectively.

CONDENSED

GAIN AND FREQUENCY ADJUSTMENTS

Range	Thermo-couple	Attenuation (DB)	Gain @ 400 cps	20 cps	10MC	21MC	50MC
100 mv	1 v	20	-	R-302	C-105	C-304	C-308/C-403
300 mv	1 v	10	-	-	C-106	-	-
1 v	1 v	0	R-138	-	C-107	-	-
3 v	3 v	0	-	-	C-108	-	-
10 v	10 v	0	-	-	C-102	-	-
1 mv	1 v	60	-	-	-	C-304	C-308
3 mv	1 v	50	-	-	C-118	-	-
10 mv	1 v	40	R-121	R-302	C-119	-	-
30 mv	1 v	30	-	-	C-120	-	-

MODEL 1202
10:1 DIVIDER PROBE

1. GENERAL.

a. The Model 1202 10:1 Divider Probe is a resistive-capacitive probe with an input impedance of 10 megohms, 8 picofarads. Its frequency spectrum is from dc to 50 megacycles, and it measures potentials to 300 volts.

b. Primary use of the Probe is to increase the input impedance of Keithley wideband voltmeters and amplifiers. Besides reducing circuit loading effects, the Model 1202 allows for more convenient measurements. Although primarily designed for Keithley voltmeters, it can be used with other quality instruments.

c. Principal parts of the Model 1202 are a probe body, a detachable probe tip and a removable 3-foot connecting cable.

2. SPECIFICATIONS.

VOLTAGE RANGE: To 300 volts.
FREQUENCY RANGE: dc to 50 megacycles.

10 to 300 millivolts	300 millivolts to 300 volts
±5%, dc to 10 megacycles	±2%, dc to 10 megacycles
±10%, dc to 20 megacycles	±5%, dc to 30 megacycles
	±10%, dc to 50 megacycles

INPUT IMPEDANCE: 10 megohms shunted by 8 picofarads.
CONNECTOR: To Voltmeter Input: Teflon-insulated uhf-type plug.

3. OPERATING PROCEDURES.

a. Note the voltmeter and Probe frequency spectrums; the Model 1202 has a narrower response than Keithley's wideband instruments.

b. Check the Probe adjustment (see paragraph 4). Connect the uhf-type plug on the cable assembly to the INPUT Receptacle on the voltmeter. To maintain the Probe's specified accuracy, use only the furnished cable assembly. Do not lengthen it; this increases electrostatic and magnetic pickup and introduces inductive problems at high frequencies.

NOTE

Use the Input Adapter, Model 1041-1, if the Probe is used with the Keithley Model 104 Wideband Amplifier.

c. Hold the Model 1202 by the aluminum body (1, Figure 1), behind the ground cable assembly as if it were a pencil. Keep your hand on the grounded body to prevent introducing sources of extraneous pickup and to prevent an increase in the input capacity of the probe. This produces the best signal-to-noise ratio and minimizes probe loading effects on the circuit.

d. Multiply voltmeter readings by 10 to determine the unknown potential. Add the Probe accuracy to the voltmeter accuracy to obtain the total accuracy.

e. The Probe also accomodates banana plugs and alligator clips. Unscrew the probe tip (7, Figure 1) and screw the new tip on the stud (6, Figure 1). An alligator clip can also be inserted over the banana plug on the ground cable assembly.

f	1 cps	10 cps	100 cps	1 kc	10 kc	100 kc	1 Mc	10 Mc	50 Mc
Z	10 MΩ	10 MΩ	9.5 MΩ	6.7 MΩ	1.7 MΩ	190 kΩ	20 kΩ	2 kΩ	400 Ω

TABLE 1. Approximate Model 1202 Input Impedance (Z) vs. Frequency (f).

4. ADJUSTMENTS.

a. The dc voltage ratio of the divider is fixed by the 9-megohm resistor in the probe and the 1-megohm input resistance of the Keithley wideband voltmeter. The high-frequency ratio is set with an adjustable capacity divider.

b. Check the 10:1 ratio by measuring a known reference, ±0.5%, at approximately 1 volt and at 350 kc or higher. To adjust the Model 1202, loosen the locking ring (3, Figure 1) and turn the capacitor adjusting screw (4, Figure 1). Tighten the locking ring by hand after the proper ratio is reached.

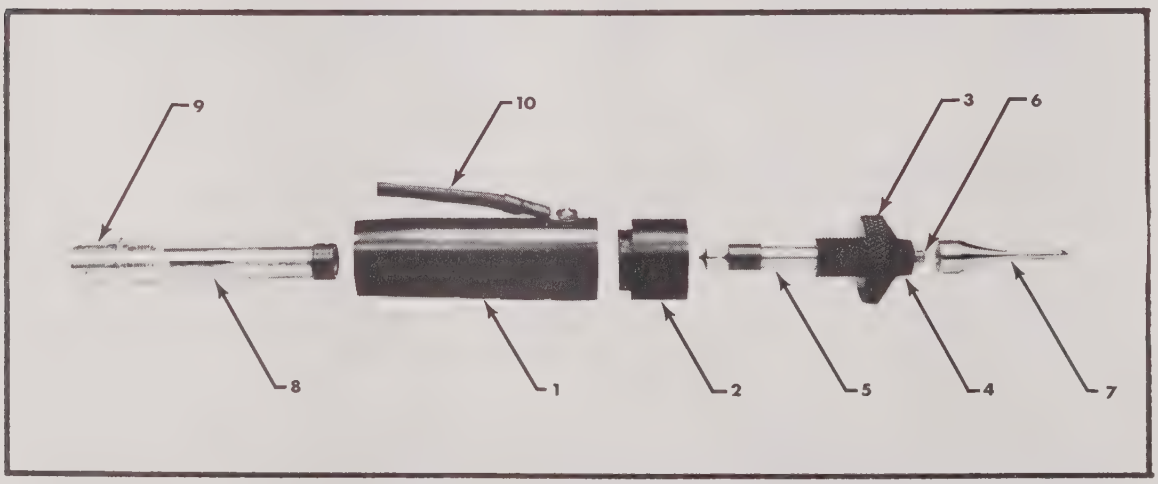


FIGURE 1. Model 1202 Exploded View.

5. REPLACEABLE PARTS.

a. For parts orders, include the Keithley Part Number and a description of the part. All structural parts must be ordered from Keithley Instruments, Inc., or its distributors. In ordering a part not listed in the Replaceable Parts List, completely describe the part, its function and its location.

b. Order parts through the nearest Keithley distributor or Sales Service Department, Keithley Instruments, Inc.

Item, Fig. 1.	Description	Mfg. Code	Keithley Part No.
-	*Model 1202 Probe	80164	---
1	.Probe Housing	80164	16500B
2	.Ring	80164	16397A
3	.Locking Ring	80164	16395A
4	.Capacitor Adjusting Screw	80164	16399A
5	.Movable Piston	80164	16394A
-	.Resistor (within 16394A) 9 MΩ, 1%, 1/2 w, deposited carbon	01295	R97-9M
6	.Stud	80164	16522A
7	.Probe Tip	80164	12908A
8	.Fixed Tube	80164	16398A
-	.Resistor (within 16398A) 124 Ω, 1%, 1/8 w, metal film	75042	R88-124
9	.Connector, bnc type	80164	16523A
10	.Ground Cable Assembly	80164	16525B
-	..Banana Plug (Mfg. No. 108-303)	74970	BG-5
-	..Cable	80164	16608B
-	.Cable Assembly	80164	16502B
-	..Plug, bnc (Mfg. No. 5396)	91737	CS-117
-	..Plug, uhf, Mil. No. 49190 (Mfg. No. 5127)	91737	CS-49
-	..Coaxial Resistive Cable, 80 Ω/ft.	80164	16518B

*This apparatus licensed under United States Letters Patent No. 2,883,619 owned by Tektronix, Inc.

TABLE 2. Model 1202 Replaceable Parts List.

01295	Texas Instruments, Inc. Semi-Conductor Products Div. Dallas, Texas	80164	Keithley Instruments, Inc. Cleveland, Ohio
74970	Johnson, E. F., Co. Waseca, Minn.	91737	Gremar Mfg. Co., Inc. Wakefield, Mass.
75042	International Resistance Co. Philadelphia, Pa.		

TABLE 3. Code List of Suggested Manufacturers. (Based on Federal Supply Code for Manufacturers, Cataloging Handbook H4-1.)

KEITHLEY INSTRUMENTS, INC.

12415 EUCLID AVENUE CLEVELAND, OHIO 44106

MODEL 1203

10:1 DIVIDER PROBE

1. GENERAL.

a. The Model 1203 10:1 Divider Probe is a capacitive probe with an input capacity of five picofarads. It does not respond to dc; its frequency spectrum is from 20 kc to 50 megacycles. The Probe measures potentials to 300 volts.

b. Primary use of the Probe is to increase the input impedance of Keithley wideband voltmeters and amplifiers. Its 60-cps rejection is approximately 30 db. The Model 1203 also allows for more convenient measurements. Although designed primarily for Keithley voltmeters, it can be used with other quality instruments.

c. Principal parts of the Model 1203 are a probe housing, a detachable probe tip and a removable 3-foot connecting cable.

2. SPECIFICATIONS.

VOLTAGE RANGE: To 300 volts.
FREQUENCY RANGE: 50 kc to 50 megacycles.

10 to 300 millivolts	300 millivolts to 300 volts
±5%, 50 kc to 10 megacycles	±2%, 50 kc to 10 megacycles
±10%, 30 kc to 20 megacycles	±5%, 30 kc to 30 megacycles
	±10%, 20 kc to 50 megacycles

INPUT IMPEDANCE: 5 picofarads.
CONNECTOR: To Voltmeter Input: Teflon-insulated uhf-type plug.

3. OPERATING PROCEDURES.

a. Note the voltmeter and Probe frequency spectrums; the Model 1203 has a narrower response than Keithley's wideband instruments.

b. Check the Probe adjustment (see paragraph 4). Adjust the Probe everytime the voltmeter range is changed. This is necessary because the input capacity may change slightly between ranges. For instance, a 1-picofarad change in the voltmeter input capacity can introduce a division ratio inaccuracy of 2% — the Probe's specified accuracy — although the Probe input capacity will be changed by only about 0.1 picofarad.

c. Connect the uhf-type plug on the cable assembly to the INPUT Receptacle on the voltmeter. To maintain the Probe's specified accuracy, use only the furnished cable assembly. Do not lengthen it; this increases electrostatic and magnetic pickup, and introduces inductive problems at high frequencies.

NOTE

Use the Input Adapter, Model 1041-1, if the Probe is used with the Keithley Model 104 Wideband Amplifier.

d. Hold the Model 1203 by the connector (9, Figure 1) behind the ground cable assembly. This prevents the introduction of sources of extraneous pickup and prevents an increase in the Probe input capacity. This produces the best signal-to-noise ratio and minimizes Probe loading effects on the circuit. The Probe is easy to handle in this way because it is small and lightweight.

e. Multiply voltmeter readings by 10 to determine the potential of the source. Add the Probe accuracy to the voltmeter accuracy to obtain the total accuracy.

f. The Probe also accommodates banana plugs and alligator clips. Unscrew the probe tip (7, Figure 1) and screw the new tip on the stud (6, Figure 1). An alligator clip can also be inserted over the banana plug on the ground Cable assembly.

f	50 kc	100 kc	1 Mc	10 Mc	50 Mc
Z	620 kΩ	310 kΩ	31 kΩ	3.1 kΩ	620 Ω

TABLE 1. Approximate Model 1203 Input Impedance (Z) vs. Frequency (f).

4. ADJUSTMENTS.

a. Calibrate the Model 1203 for each voltmeter range. Check the 10:1 ratio by measuring a known reference, ±0.5%, at 350 kc or higher. Use a source which will indicate at least half-scale on the voltmeter. To adjust the Model 1203, loosen the locking ring (3, Figure 1) and rotate the front barrel of the Probe while the probe tip is connected to the known signal. Tighten the locking ring by hand after the proper ratio is reached.

b. It may be necessary to set the meter indication slightly high, since tightening may lower the meter indication. Also, keep your hands behind the probe ground lead before checking the accuracy.

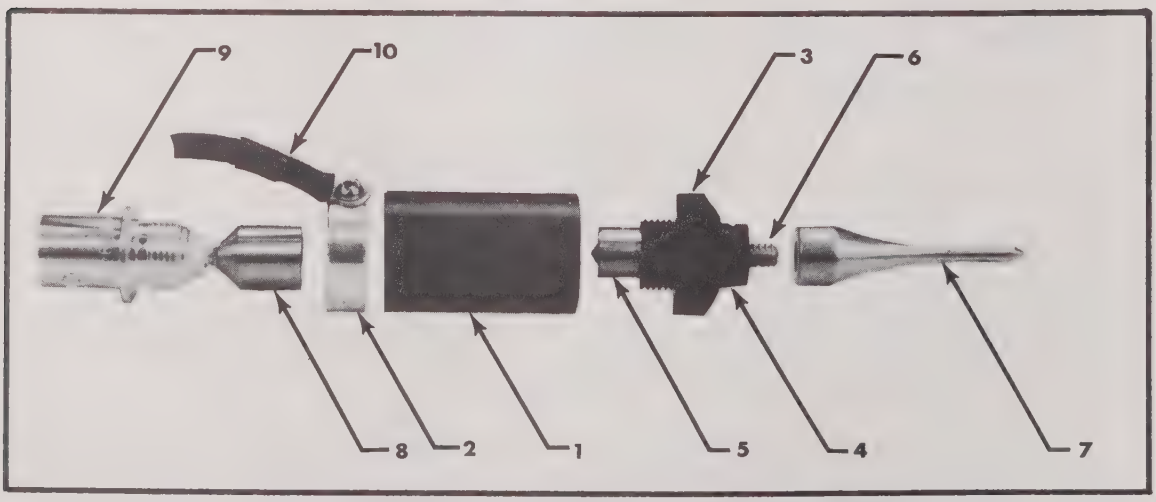


FIGURE 1. Model 1203 Exploded View.

5. REPLACEABLE PARTS.

a. For parts orders, include the Keithley Part Number and a description of the part. All structural parts must be ordered from Keithley Instruments, Inc.,

or its distributors. In ordering a part not listed in the Replaceable Parts List, completely describe the part, its function and its location.

b. Order parts through the nearest Keithley distributor or Sales Service Department, Keithley Instruments, Inc.

Item, Fig. 1	Description	Mfg. Code	Keithley Part No.
-	*Model 1203 Probe	80164	---
1	.Probe Housing	80164	16503A
2	.Ground Ring	80164	16504A
3	.Locking Ring	80164	16506A
4	.Capacitor Adjusting Screw	80164	16502B
5	.Movable Piston	80164	16507A
-	.Resistor (within 16507A) 715 Ω, 1%, 1/2 w, metal film	75042	R98-715
6	.Stud	80164	16521A
7	.Probe Tip	80164	12908A
8	.Fixed Piston	80164	16505A
9	.Connector, bnc, Mil.No. UG-1094/U (Mfg. No. 31-221)	02660	CS-15
10	.Ground Cable Assembly	80164	16524B
-	..Banana Plug (Mfg. No. 108-303)	74970	BG-5
-	..Cable	80164	16609B
-	.Cable Assembly	80164	16520B
-	..Coaxial Resistive Cable, 80 Ω/ft	80164	16518B
-	..Plug, bnc (Mfg. No. 5396)	91737	CS-117
-	..Plug, uhf, Mil.No. 49190 (Mfg. No. 5127)	91737	CS-49

*This apparatus licensed under United States Letters Patent No. 2,883,619 owned by Tektronix, Inc.

TABLE 2. Model 1203 Replaceable Parts List.

02660	Amphenol Conductor Division Amphenol-Borg Electronics Corp. Chicago, Illinois	80164	Keithley Instruments, Inc. Cleveland, Ohio
74970	Johnson, E. F., Co. Waseca, Minn.	91737	Gremar Mfg. Co., Inc. Wakefield, Mass.
75042	International Resistance Co. Philadelphia, Pa.		

TABLE 3. Code List of Suggested Manufacturers. (Based on Federal Supply Code for Manufacturers, Cataloging Handbook H4-1.)

KEITHLEY INSTRUMENTS. INC.

12415 EUCLID AVENUE CLEVELAND, OHIO 44106

SECTION 6. REPLACEABLE PARTS

6-1. REPLACEABLE PARTS LIST. The Replaceable Parts List describes the components of the Models 120 and 120R and their accessories. The List gives the circuit designation, the part description, a suggested manufacturer and the Keithley Part Number. The name and address of the manufacturers listed in the "Mfg. Code" column is contained in Table 14. Unless noted, all components are for both models.

6-2. HOW TO ORDER PARTS.

a. For parts orders, include the instrument's model and serial number, the Keithley Part Number, the circuit designation and a description of the part. All structural parts and those parts coded for Keithley manufacture (80164) must be ordered from Keithley Instruments, Inc. In ordering a part not listed in the Replaceable Parts List, completely describe the part, its function and its location.

b. Order parts through:

Sales Service Department
Keithley Instruments, Inc.
12415 Euclid Avenue
Cleveland, Ohio 44106
Telephone 795-2666, Area Code 216

amp	ampere	M or meg	mega (10^6) or megohms
		m	milli (10^{-3})
CbVar	Carbon Variable	Mfg	Manufacturer
CerD	Ceramic, Disc	Mil. No.	Military Type Number
CerS	Ceramic, Standoff	u	micro (10^{-6})
CerT	Ceramic, Tubular	MtF	Metal Film
Comp	Composition	My	Mylar
DCb	Deposited Carbon		
EMC	Electrolytic, Metal Cased	p	pico (10^{-12})
ETB	Electrolytic, Tubular		
ETT	Electrolytic, Tantalum	v	volt
		Var	Variable
f	farad		
FT	Feed Through	w	watt
		WW	Wirewound
h	Henry	WWVar	Wirewound Variable
k	kilo (10^3)		

TABLE 13. Abbreviations and Symbols.

MODELS 120, 120R REPLACEABLE PARTS LIST
(Refer to 15099E for circuit designations)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
C101	0.1 uf	400 v	My	13050	C86-0.1M
C102	4.5/25 pf	500 v	Trimmer	71590	C76-4.5/25P
C103	3.3 pf	600 v	CerT	00656	C77-3.3P
C104	2.2 pf	600 v	CerT	00656	C77-2.2P
C105	1.5/7 pf	500 v	Trimmer	71590	C76-1.5/7P
C106	3/12 pf	500 v	Trimmer	71590	C76-3/12P
C107	4.5/25 pf	500 v	Trimmer	71590	C76-4.5/25P
C108	4.5/25 pf	500 v	Trimmer	71590	C76-4.5/25P
C109	470 pf	600 v	CerD	72982	C22-470P
C110	6.8 uf	35 v	ETT	05397	C81-6.8M
C111	.02 uf	600 v	CerD	72982	C22-.02M
C112	.02 uf	600 v	CerD	72982	C22-.02M
C113	.02 uf	600 v	CerD	72982	C22-.02M
C114	470 pf	350 v	CerS	00656	C16-470P
C115	.02 uf	600 v	CerD	72982	C22-.02M
C116	100 uf	10 v	ETT	01295	C78-100M
C117	100 uf	10 v	ETT	01295	C78-100M
C118	3/12 pf	500 v	Trimmer	71590	C76-3/12P
C119	3/12 pf	500 v	Trimmer	71590	C76-3/12P
C120	1.5/3 pf	500 v	Trimmer	71590	C76-1.5/3P
C121	10 pf	600 v	CerT	71590	C77-10P
C122	30 pf	600 v	CerT	71590	C77-30P
C123	30 pf	600 v	CerT	71590	C77-30P
C124	470 pf	600 v	CerD	72982	C22-470P
C125	6.8 uf	35 v	ETT	05397	C81-6.8M
C126	.02 uf	600 v	CerD	72982	C22-.02M
C127	.02 uf	600 v	CerD	72982	C22-.02M
C128	.02 uf	600 v	CerD	72982	C22-.02M
C129	.02 uf	600 v	CerD	72982	C22-.02M
C130	470 pf	350 v	CerS	00656	C16-470P
C131	470 pf	350 v	CerS	00656	C16-470P
C132	.02 uf	600 v	CerD	72982	C22-.02M
C133	.02 uf	600 v	CerD	72982	C22-.02M
C134	100 uf	10 v	ETT	01295	C78-100M
C135	100 uf	10 v	ETT	01295	C78-100M
C136	.02 uf	600 v	CerD	72982	C22-.02M
C137	5 pf	600 v	CerD	72982	C22-5P
C138	*110 pf	600 v	CerT	00656	C77-110P

*Nominal value, factory selected

CAPACITORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
C139	100 uf	10 v	ETT	01295	C78-100M
C140	470 pf	350 v	CerS	00656	C16-470P
C141	.02 uf	600 v	CerD	72982	C22-.02M
C142	.01 uf	600 v	CerD	01121	C22-.01M
C143	33 uf	10 v	ETT	01295	C78-33M
C144	15 pf	600 v	CerT	71590	C77-15P
C145	100 uf	15 v	ETT	01295	C75-100M
C146	100 uf	15 v	ETT	01295	C79-100M
C147	6 uf	100 v	ETB	14655	C60-6M
C148	100 uf	15 v	ETT	01295	C79-100M
C149	20 uf	100 v	ETB	14655	C60-20M
C150	100 uf	15 v	ETT	01295	C79-100M
C151	330 uf	6 v	ETT	01295	C5-330M
C152	.75 pf	600 v	CerT	71590	C77-.75P
C153	47 pf	600 v	CerT	71590	C77-47P
C154	18 pf	600 v	CerT	00656	C77-18P
C155	0.3 pf	600 v	CerT	00656	C77-0.3P
C156	10 pf	600 v	CerT	71590	C77-10P
C157	6.8 uf	600 v	CerT	00656	C77-6.8P
C158	4.7 pf	600 v	CerT	00656	C77-4.7P
C201	40 uf	200 v	EMC	53021	C19-40M
C202	500 uf/500 uf	35 v/35 v	EMC dual	53021	C20-500/500M
C203	500 uf/500 uf	35 v/35 v	EMC dual	53021	C20-500/500M
C204	100 pf	600 v	CerD	72982	C22-100P
C205	1.2 uf	15 v	ETT	05397	C80-1.2M
C206	500 uf	12 v	EMC	53021	C24-500M
C207	100 uf	25 v	ETT	05079	C96-100M
C208	80 uf/40 uf	80 v/80 v	EMC dual	53021	C25-80/40M
C209	500 uf/500 uf	35 v/35 v	EMC dual	53021	C20-500/500M
C210	500 uf/500 uf	35 v/35 v	EMC dual	53021	C20-500/500M
C211	80 uf/40 uf	80 v/80 v	EMC dual	53021	C25-40/80M
C212	150 uf	80 v	EMC	53021	C26-150M
C213	500 uf	25 v	EMC	53021	C40-500M
C214	1.0 uf	25 v	CerD	56289	C85-1.0M
C215	1 uf	200 v	My	02777	C66-1M
C216	470 pf	600 v	CerD	72982	C22-470P
C217	470 pf	600 v	CerD	72982	C22-470P
C218	470 pf	600 v	CerD	72982	C22-470P
C219	470 pf	600 v	CerD	72982	C22-470P
C220	0.22 uf	50 v	My	84411	C41-.22M

CAPACITORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
C221	0.22 uf	50 v	My	84411	C41-.22M
C222	500 pf	1000 v	FT	71590	C15-500P
C223	500 pf	1000 v	FT	71590	C15-500P
C224	20 uf	100 v	ETB	14655	C60-20M
C225	0.1 uf	50 v	My	84411	C41-0.1M
C226	0.1 uf	50 v	My	84411	C41-0.1M

DIODES

Circuit Desig.	Type	Number	Mfg. Code	Keithley Part No.
D101	Silicon	1N3252	02735	RF-17
D102	Silicon	1N1563A	04713	RF-19
D103	Silicon	1N1563A	04713	RF-19
D104	Silicon	1N482	12065	RF-14
D105	Not Used			
D106	Silicon	1N3252	02735	RF-17
D107	Silicon	1N3252	02735	RF-17
D108	Silicon	1N3253	02735	RF-20
D109	Silicon	1N3253	02735	RF-20
D110	Zener	1N935	04713	DZ-7
D111	Zener	1N1314	99942	DZ-2

MISCELLANEOUS

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
---	Pilot Light Bracket Assembly	72619	PL-5G
DS-1	Bulb, Lamp (Mfg. No. 47)	08804	PL-4
---	Fuse Holder	75915	FH-3
F1 (117v)	Fuse, Slo Blow, 0.75 amp, 3 AG	75915	FU-19
F1 (234v)	Fuse, Slo Blow, 0.38 amp, 3 AG	75915	FU-18
J1	Receptacle, uhf, INPUT, Mil No. SO-239A (Mfg. No. 6804)	91737	CS-64
---	Binding Post, G, Front panel (Mfg. No. 137)	83330	BP-15
J2	Banana Jack, 10 V CALIBRATION SIGNAL (Mfg. No. 108-902)	74970	BJ-6R
J3	Banana Jack, 10 MV CALIBRATION SIGNAL (Mfg. No. 108-902)	74970	BJ-6R
J4	Banana Jack, GND CALIBRATION SIGNAL (Mfg. No. 108-902)	74970	BJ-6B

MISCELLANEOUS (Cont'd)

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
J5	Receptacle, uhf, OUTPUT, Mil No. SO-239 (Mfg. No. 6804)	91737	CS-64
---	Binding Post, G, Rear panel (Mfg. No. 137)	83330	BP-15
J6	Receptacle, PROBE, (Mfg. No. XLR-5-31)	71468	CS-3
L1	Choke, 1 uh	80164	CH-2
M1	Meter, 200 uamp dc	80164	ME-45
15046B	Three-stage AC Amplifier, See pg. 6-8 for parts list.	80164	15046B
15051B	Two-stage AC Amplifier, See pg. 6-9 for parts list.	80164	15051B
P1	Cord Set, 6 feet	80164	CO-2
---	Cable Clamp	80164	CC-7
P2	Plug, uhf, Mate of J1 and J2, Mil. No. 49190 (Mfg. No. 5127)	91737	CS-49
S1	Rotary, Switch less components, RANGE	80164	SW-136
	(Switch Sub-assembly with shields)	80164	15030B
---	Knob Assembly, Range Switch	80164	15017A
S2	Toggle Switch, SPST, ON	80164	SW-4
---	Knob Assembly, Zero Potentiometer	80164	15110A
T1	Transformer, Power Supply	80164	TR-59
T2	Transformer, Switching	80164	TR-22

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
R101	990 kohm	0.5%, ½ w	MtF	75042	R61-990K
R102	10.1 kohm	0.5%, ½ w	MtF	75042	R61-10.1K
R103	850.0 kohm	0.5%, ½ w	MtF	75042	R61-850.0K
R104	952.6 kohm	0.5%, ½ w	MtF	75042	R61-952.6K
R105	985.0 kohm	0.5%, ½ w	MtF	75042	R61-985.0K
R106	995.3 kohm	0.5%, ½ w	MtF	75042	R61-995.3K
R107	150.0 kohm	0.5%, ½ w	MtF	75042	R61-150.0K
R108	47.44 kohm	0.5%, ½ w	MtF	75042	R61-47.44K
R109	*15 ohm	5%, ½ w	Comp	01121	R19-15
R110	15.00 kohm	0.5%, ½ w	MtF	75042	R61-15.00K
R111	*15 ohm	5%, ½ w	Comp	01121	R19-15
R112	4.744 kohm	0.5%, ½ w	MtF	75042	R61-4.744K
R113	1 Mohm	0.5%, ½ w	MtF	75042	R61-1M

*Nominal value, factory selected

RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
R114	220 ohm	10%, ¼ w	Comp	44655	R76-220
R115	1.2 kohm	10%, ¼ w	Comp	01121	R76-1.2K
R116	10 ohm	10%, ¼ w	Comp	44655	R76-10
R117	1.5 kohm	10%, ½ w	Comp	01121	R1-1.5K
R118	100 ohm	10%, ¼ w	Comp	01121	R76-100
R119	10 ohm	10%, ¼ w	Comp	44655	R76-10
R120	300 ohm	0.5%, ¼ w	MtF	75042	R75-300
R121	1 kohm	20%, ½ w	CbVar	71450	RP31-1K
R122	300 ohm	0.5%, ¼ w	MtF	75042	R75-300
R123	6.838 kohm	0.5%, ½ w	MtF	75042	R61-6.838K
R124	9.000 kohm	0.5%, ½ w	MtF	75042	R61-9.000K
R125	9.684 kohm	0.5%, ½ w	MtF	75042	R61-9.684K
R126	10 kohm	10%, ¼ w	Comp	44655	R76-10K
R127	3.162 kohm	0.5%, ½ w	MtF	75042	R61-3.162K
R128	1.000 kohm	0.5%, ½ w	MtF	75042	R61-1.000K
R129	316.2 ohm	0.5%, ½ w	MtF	75042	R61-316.2
R130	*68 ohm	5%, ½ w	Comp	01121	R19-68
R131	100 ohm	10%, ¼ w	Comp	01121	R76-100
R132	10 ohm	10%, ¼ w	Comp	44655	R76-10
R133	3.3 kohm	10%, ½ w	Comp	44655	R1-3.3K
R134	100 ohm	10%, ¼ w	Comp	01121	R76-100
R135	10 ohm	10%, ¼ w	Comp	44655	R76-10
R136	1 kohm	0.5%, ¼ w	MtF	75042	R75-1K
R137	450 ohm	0.5%, ¼ w	MtF	75042	R75-450
R138	1 kohm	20%, ½ w	CbVar	71450	RP31-1K
R139	10 ohm	10%, ¼ w	Comp	44655	R76-10
R140	330 kohm	10%, ¼ w	Comp	01121	R76-330K
R141	47 ohm	10%, ¼ w	Comp	44655	R76-47
R142	330 kohm	10%, ¼ w	Comp	01121	R76-330K
R143	127 ohm	1%, ½ w	DCb	00327	R12-127
R144	60 ohm	1%, ½ w	DCb	01661	R12-60
R145	10 ohm	10%, ¼ w	Comp	44655	R76-10
R146	3.3 kohm	10%, ½ w	Comp	44655	R1-3.3K
R147	100 ohm	10%, ¼ w	Comp	01121	R76-100
R148	55 kohm	1%, ½ w	DCb	00327	R12-55K
R149	15 kohm	10%, 2 w	WWVar	37942	RP3-15K
R150	100 kohm	1%, ½ w	DCb	01661	R12-100K
R151	6 kohm	1%, ½ w	DCb	00327	R12-6K
R152	5 kohm	1%, ½ w	DCb	00327	R12-5K
R153	1 kohm	10%, ¼ w	Comp	01121	R76-1K

*Nominal value, factory adjusted.

RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
R154 (a)	2 kohm	10%, 2 w	WWVar	71450	RP3A-2K
R154 (r)	2 kohm	10%, 5 w	WWVar	71450	RP34A-2K
R155	1 kohm	1%, ½ w	DCb	01661	R12-1K
R156	*15 ohm	5%, ½ w	Comp	01121	R19-15
R157	47 ohm	10%, ¼ w	Comp	44655	R76-47
R158	1 kohm	10%, ¼ w	Comp	01121	R76-1K
R159 (a)	2 kohm	20%, ½ w	CbVar	71450	RP31-2K
R159 (r)	2 kohm	10%, 5 w	WWVar	71450	RP34A-2K
R160	10 ohm	10%, ¼ w	Comp	44655	R76-10
R161	10 ohm	10%, ¼ w	Comp	44655	R76-10
R201	27 kohm	10%, 1 w	Comp	01121	R2-27K
R202	0.5 ohm	3%, 10 w	WW	44655	R66-0.5
R203	560 ohm	1%, ½ w	DCb	00327	R12-560
R204	10 kohm	10%, ½ w	Comp	01121	R1-10K
R205	10 kohm	10%, ½ w	Comp	01121	R1-10K
R206	300 ohm	1%, ½ w	DCb	00327	R12-300
R207	10 kohm	10%, ½ w	Comp	01121	R1-10K
R208	4.7 kohm	10%, ½ w	Comp	01121	R1-4.7K
R209	Not Used				
R210	600 ohm	1%, ½ w	DCb	01661	R12-600
R211	Not Used				
R212	27 ohm	10%, ½ w	Comp	44655	R1-27
R213	Not Used				
R214	10 ohm	10%, ½ w	Comp	01121	R1-10
R215	25 ohm	10%, 5 w	WW	44655	R4A-25
R216	1.5 kohm	10%, ½ w	Comp	01121	R1-1.5K
R217	22 kohm	10%, ½ w	Comp	44655	R1-22K
R218	47 ohm	10%, 2 w	Comp	44655	R3-47
R219	470 ohm	10%, ½ w	Comp	01121	R1-470
R220	10 kohm	10%, ½ w	Comp	01121	R1-10K
R221	1 ohm	10%, 5 w	WW	44655	R4A-1
R222	20 ohm	1%, ½ w	DCb	00327	R12-20
R223	20 kohm	1%, ½ w	DCb	01661	R12-20K
R224	34 kohm	1%, ½ w	DCb	00327	R12-34K
R225	200 ohm	1%, ½ w	DCb	01661	R12-200
R226	15 ohm	10%, 5 w	WW	44655	R4A-15
R227	2.2 kohm	10%, ½ w	Comp	44655	R1-2.2K
R228	3 kohm	20%, ½ w	CbVar	71450	RP31-3K
R229	2 kohm	20%, ½ w	CbVar	71450	RP31-2K
R230	1 kohm	10%, ½ w	Comp	01121	R1-1K

*Nominal value, factory selected
(a) Used on only Model 120
(r) Used on only Model 120R
0863R

RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
R231 (a)	200 ohm	10%, 2 w	WWVar	71450	RP38-200
R231 (r)	200 ohm	10%, 2 w	WWVar	71450	RP3A-200
R232	*100 ohm	1%, ½ w	DCb	01661	R12-100

TRANSISTORS

Circuit Desig.	Number	Mfg. Code	Keithley Part No.
Q1	2N1535	04713	TG-7
Q2	2N1183	02735	TG-11
Q3	2N1381	01295	TG-8
Q4	2N1381	01295	TG-8
Q5	2N1381	01295	TG-8
Q6	2N1381	01295	TG-8
Q7	2N1183	02735	TG-11
Q8	2N1183	02735	TG-11
Q9	2N1183	02735	TG-11
Q10	2N1183	02735	TG-11

VACUUM TUBES

Circuit Desig.	Number	Mfg. Code	Keithley Part No.
V1	7586	86684	EV-7586
V2	7586	86684	EV-7586
V3	7586	86684	EV-7586
V4	6AL5	86684	EV-6AL5

ASSEMBLY 15046B REPLACEABLE PARTS LIST
(Refer to 15098C for circuit designations)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
C301	33 uf	10 v	ETT	01295	C78-33M
C302	2.7 uf	20 v	ETT	05397	C80-2.7M
C303	100 uf	10 v	ETT	01295	C78-100M
C304	1.5/7 pf	500 v	Trimmer	71590	C76-1.5/7P
C305	68 uf	15 v	ETT	01295	C79-68M
C306	100 uf	10 v	ETT	01295	C78-100M
C307	100 uf	10 v	ETT	01295	C78-100M
C308	4.5/25 pf	500 v	Trimmer	71590	C76-4.5/25P

*Nominal value, factory selected
(a) Used on only Model 120
(r) Used on only Model 120R

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
R301	470 ohm	10%, ¼ w	Comp	01121	R76-470
R302	50 kohm	2 w	CbVar	80294	RP30-50K
R303	2.2 kohm	10%, ¼ w	Comp	44655	R76-2.2K
R304	2.2 kohm	10%, ¼ w	Comp	44655	R76-2.2K
R305	75 ohm	0.5%, ¼ w	MtF	75042	R75-75
R306	560 ohm	10%, ¼ w	Comp	01121	R76-560
R307	68 kohm	10%, ¼ w	Comp	44655	R76-68K
R308	47 kohm	10%, ¼ w	Comp	01121	R76-47K
R309	470 ohm	10%, ¼ w	Comp	01121	R76-470
R310	2.2 kohm	10%, ¼ w	Comp	44655	R76-2.2K
R311	2.2 kohm	10%, ¼ w	Comp	44655	R76-2.2K
R312	1.00 kohm	0.5%, ¼ w	MtF	75042	R75-1.00K
R313	68 kohm	10%, ¼ w	Comp	44655	R76-68K
R314	500 ohm	0.5%, ¼ w	MtF	75042	R75-500
R315	2.2 kohm	10%, ¼ w	Comp	44655	R76-2.2K
R316	2.2 kohm	10%, ¼ w	Comp	44655	R76-2.2K
R317	100 ohm	0.5%, ¼ w	MtF	75042	R75-100
R318	3.3 kohm	10%, ¼ w	Comp	01121	R76-3.3K
R319	3.3 kohm	10%, ¼ w	Comp	01121	R76-3.3K

TRANSISTORS

Circuit Desig.	Number	Mfg. Code	Keithley Part No.
Q1 to Q10	Not Used		
Q11	2N2594	87216	TG-18
Q12	2N2594	87216	TG-18
Q12 (alternate)	SM492	04713	TG-17
Q13	2N2594	87216	TG-18

ASSEMBLY 15051B REPLACEABLE PARTS LIST
(Refer to 15096C for circuit designations)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
C401	3.9 uf	10 v	ETT	01295	C78-3.9M
C402	100 uf	10 v	ETT	01295	C78-100M
C403	4.5/25 pf	500 v	Trimmer	71590	C76-4.5/25P
C404	0.47 uf	25 v	CerD	56289	C85-0.47M
C405	100 uf	10 v	ETT	01295	C78-100M
C406	100 uf	10 v	ETT	01295	C78-100M
C407	22 uf	35 v	ETT	05397	C81-22M

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
R401	1 kohm	10%, ½ w	Comp	01121	R1-1K
R402	700 ohm	0.5%, ¼ w	MtF	75042	R75-700
R403	2.2 kohm	10%, ¼ w	Comp	44655	R76-2.2K
R404	2.2 kohm	10%, ¼ w	Comp	44655	R76-2.2K
R405	47 ohm	10%, ¼ w	Comp	44655	R76-47
R406	100 ohm	0.5%, ¼ w	MtF	75042	R75-100
R407	68 kohm	10%, ¼ w	Comp	44655	R76-68K
R408	68 kohm	10%, ¼ w	Comp	44655	R76-68K
R409	1 kohm	10%, ½ w	Comp	01121	R1-1K
R410	2.2 kohm	10%, ¼ w	Comp	44655	R76-2.2K
R411	2.2 kohm	10%, ¼ w	Comp	44655	R76-2.2K

TRANSISTORS

Circuit Desig.	Number	Mfg. Code	Keithley Part No.
Q1 to Q13	Not Used		
Q14	SM492	04713	TG-17
Q15	SM492	04713	TG-17

MODEL 1201 REPLACEABLE PARTS LIST
(Refer to 15483C for circuit designations)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
C1	.01 uf	300 v	CerT	01884	C61-.01M
C2	7/25 pf	350 v	Trimmer	72982	C89-7/25P
C3	.01 uf	25 v	CerT	93958	C90-.01N
C4	.01 uf	150 v	CerS	71590	C91-.01M

MISCELLANEOUS

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
---	Plug, uhf, Output Mil. No. 49190 (Mfg. No. 5127)	91737	CS-49
---	Plug, Power (Mfg. No. XLR-5-12C)	71468	CS-4
---	Plug, bnc, Input, Mil. No. UG-1094/U (Mfg. No. 31-221)	02660	CS-15
---	Probe Tip	80164	12908A
---	Ground Clamp Assembly	80164	15471A

MISCELLANEOUS (Cont'd)

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
---	Banana Plug, Ground (Mfg. No. 108-303)	74970	BG-5
V1	Vacuum Tube, No. 7963	00011	EV-7963

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
R1	47 ohm	10%, ¼ w	Comp	44655	R76-47
R2	10 Mohm	10%, ¼ w	Comp	01121	R76-10M
R3	1 kohm	1%, 1/8 w	CbF	01295	R79-1K
R4	1 kohm	5%, 1 w	WWVar	02111	RP33-1K

MODEL 1202 REPLACEABLE PARTS LIST

Description	Mfg. Code	Keithley Part No.
Probe Tip	80164	12908A
Plug, bnc type	80164	16523A
Resistor, 124 ohm, 1%, 1/8 w, Mtf	75042	R88-124
Resistor, 9 Mohm, 1%, ½ w, Mtf	01295	R97-9M
Ground Cord Assembly	80164	16525B
Banana Plug, Ground (Mfg. No. 108-303)	74970	BG-5
Cable Assembly	80164	16520B
Plug, bnc (Mfg. No. 5396)	91737	CS-117
Plug, uhf, Mil No. 49190 (Mfg. No. 5127)	91737	CS-49

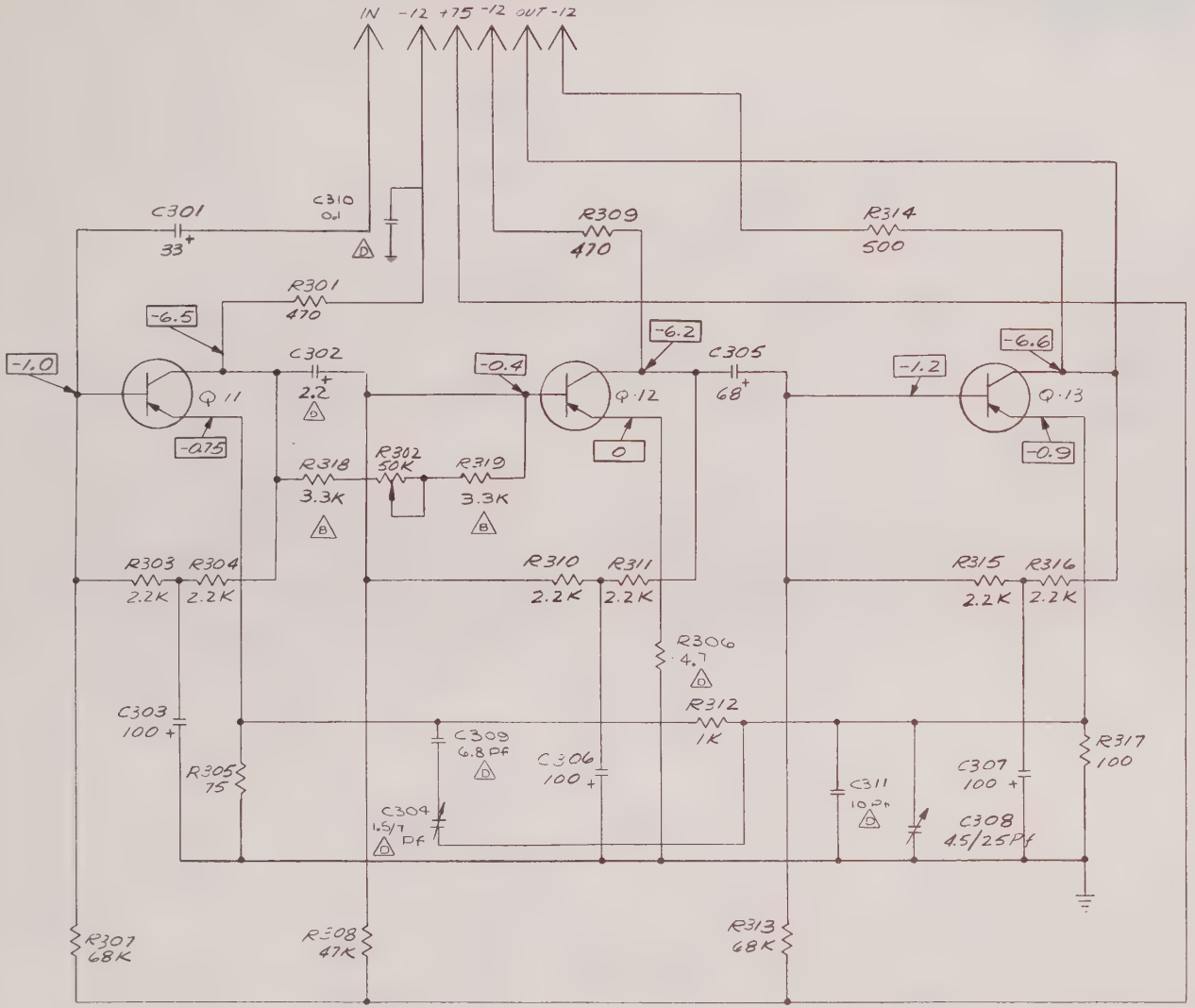
MODEL 1203 REPLACEABLE PARTS LIST

Description	Mfg. Code	Keithley Part No.
Probe Tip	80164	12908A
Plug, bnc, Mil. No. UG-1094/U (Mfg. No. 31-221)	02660	CS-15
Resistor, 715 ohm, 1%, ½ w, MtF	75042	R98-715
Ground Cord Assembly	80164	16524B
Banana Plug, Ground (Mfg. No. 108-303)	74970	BG-5
Cable Assembly	80164	16520B
Plug, bnc (Mfg. No. 5396)	91737	CS-117
Plug, uhf, Mil. No. 49190 (Mfg. No. 5127)	91737	CS-49

00011	Sylvania Electric Products, Inc. Electronic Tubes Div. Buffalo, N. Y.
00327	Welwyn International, Inc. Cleveland, Ohio
00656	Aerovox Corporation New Bedford, Mass.
01121	Allen-Bradley Corp. Milwaukee, Wis.
01295	Texas Instruments, Inc. Semi-Conductor Products Div. Dallas, Texas
01661	Wilrite Products, Inc. Cleveland, Ohio
01884	Dearborn Electronic Labs., Inc. Orlando, Fla.
02111	Spectrol Electronics Corp. San Gabriel, Calif.
02660	Amphenol Conductor Division Amphenol-Borg Electronics Corp. Chicago, Illinois
02735	Radio Corp. of America RCA Semiconductor & Materials Div. Somerville, N. J.
04713	Motorola, Inc. Semiconductor Products Division Phoenix, Arizona
05079	Tansitor Electronics, Inc. Bennington, Vt.
05397	Kemet Co. Cleveland, Ohio
08804	General Electric Co. Lamp Division Cleveland, Ohio
12065	Transitron Electronic Corp. Wakefield, Mass.
13050	Potter Co. Wesson, Miss.
14655	Cornell-Dubilier Electronics Div. of Federal Pacific Electric Co. Newark, N. J.
15909	Daven Co. Livingston, N. J.
37942	Mallory, P.R., And Co., Inc. Indianapolis, Ind.
44655	Ohmite Mfg. Co. Skokie, Ill.
53021	Sangamo Electronic Co. Springfield, Ill.
56289	Sprague Electric Co. North Adams, Mass.
71450	CTS Corp. Elkhart, Ind.
71468	Cannon Electric Co. Los Angeles, Calif.
71590	Centralab Division Globe-Union, Inc. Milwaukee, Wis.
72619	Dialight Corp. Brooklyn, N. Y.
72982	Erie Resistor Corp. Erie, Pa.
74970	Johnson, E. F., Co. Waseca, Minn.
75042	International Resistance Co. Philadelphia, Pa.
75915	Littelfuse, Inc. Des Plaines, Ill.
80164	Keithley Instruments, Inc. Cleveland, Ohio
80294	Bourns Laboratories, Inc. Riverside, Calif.
83330	Smith, Herman H., Inc. Brooklyn, N. Y.

84411	Good-All Electric Mfg. Co. Ogallala, Nebr.	91737	Gremar Mfg. Co., Inc. Wakefield, Mass.
86684	Radio Corp. of America RCA Electron Tube Div. Harrison, N. J.	93958	Mucon Corp. Newark, N. J.
87216	Philco Corp. Lansdale Division Lansdale, Pa.	99942	Hoffman Electronics Corp. Semiconductor Division El Monte, Calif.

TABLE 14. Code List of Suggested Manufacturers. (Based on Federal Supply Code for Manufacturers, Cataloging Handbook H4-1.)



REVISIONS			
SYM	DESCRIPTION		DATE
A			10-[illegible]
B	ECO 1580		12-05-62
C	ECO 1744		3/27/63
D	ECO 1860	RR	10-8-63

HIGHEST REFERENCE DESIGNATION		
C311	R320	Q-13

REFERENCE DESIGNATION NOT USED: +1-Q10

NOTE:

1.) ALL RESISTANCE & CAPACITANCE SHALL BE DESIGNATED IN OHMS & MICRO FARADS RESPECTIVELY UNLESS OTHERWISE NOTED.

2) DC VOLTAGES WHERE SHOWN ARE SUBJECT TO A NORMAL VARIATION OF ± 10%

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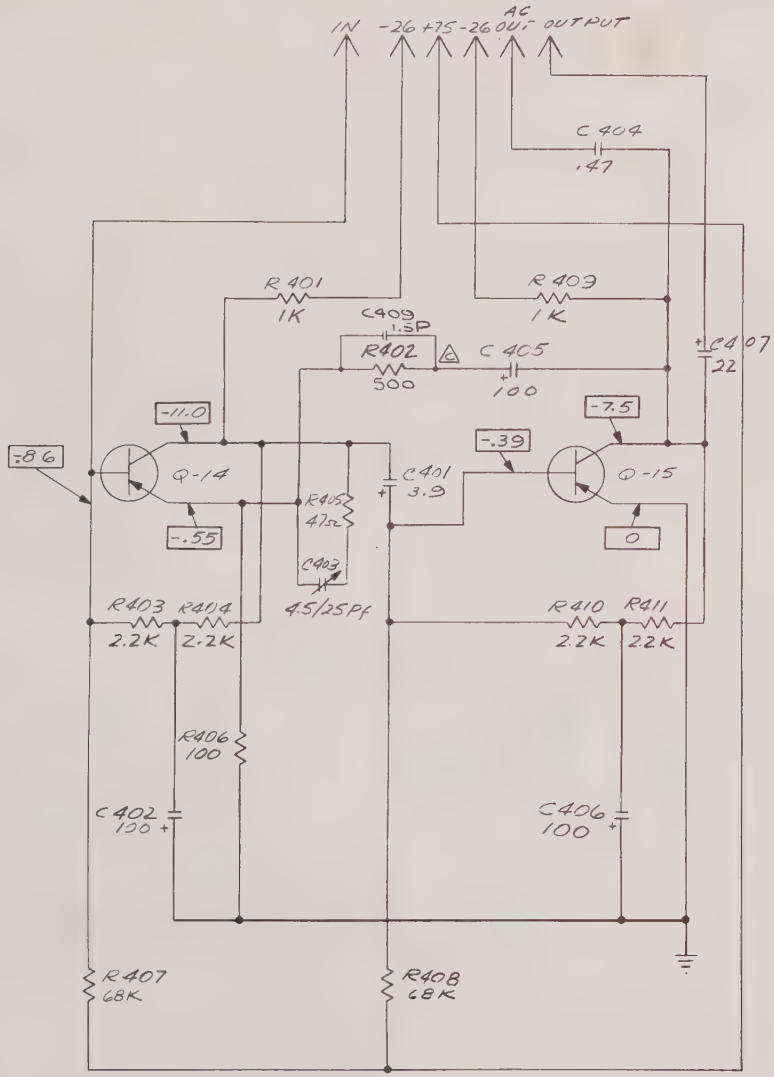
C 12/4 54 A 15400M
167 [illegible]

MATERIAL	FINISH
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPEC FILD: FRAC. ± 1/64, DEC. ± .005, ANG ± 30'	TITLE SCHEMATIC, THREE STAGE AC AMPLIFIER
SCALE: NO REQ'D	DRAWN M. FURST DATE 5/16/62
NEXT ASSY.	CHECKED DATE 6-8-62
	APPROVED DATE 9-19-62

KEITHLEY INSTRUMENTS, INC. CLEVELAND, OHIO

DRAWING NUMBER 15098C



REVISIONS		
SYM	DESCRIPTION	DATE
A.	RWMA	10-10-62
B	ECO 1744 I.S.	5/3/63
C	ECO 1860 RR	10/9/63

HIGHEST REFERENCE DESIGNATION		
R411	C409	Q-15
REFERENCE DESIGNATION NOT USED		
		Q1-Q-13

NOTE:

1.) ALL RESISTANCE & CAPACITANCE SHALL BE DESIGNATED IN OHMS & MICRO FARADS RESPECTIVELY UNLESS OTHERWISE NOTED.

2) DC VOLTAGES WHERE SHOWN ARE SUBJECT TO A NORMAL VARIATION OF ± 10%

B 120R 15400M 15400M
120 15000M 15000M

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PROPERTY OF [illegible]

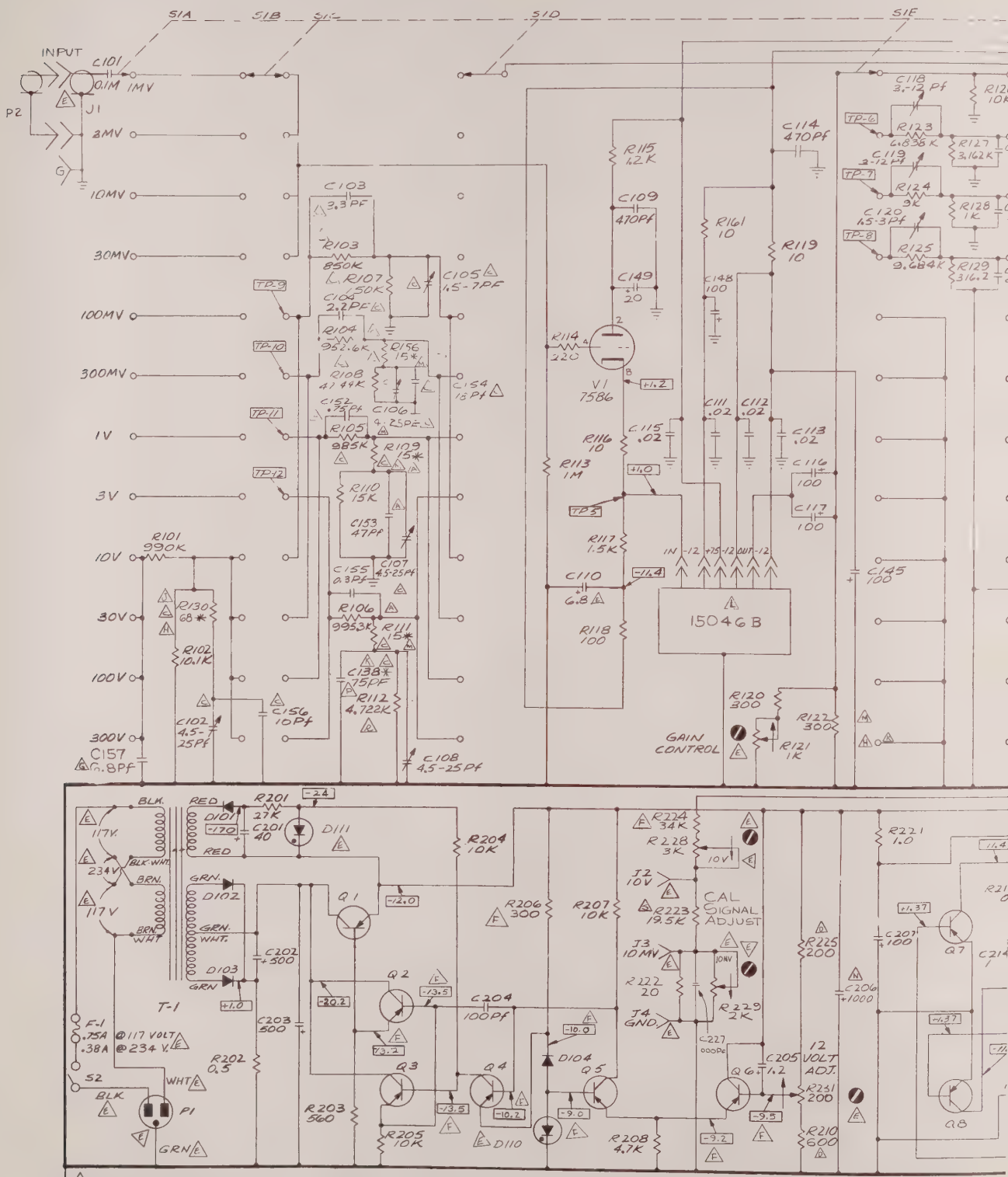
MATERIAL		FINISH	
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	FRAC ± 1/64	DEC ± .005	ANG ± 30'
SCALE	NO REQ'D		
NEXT ASSY			

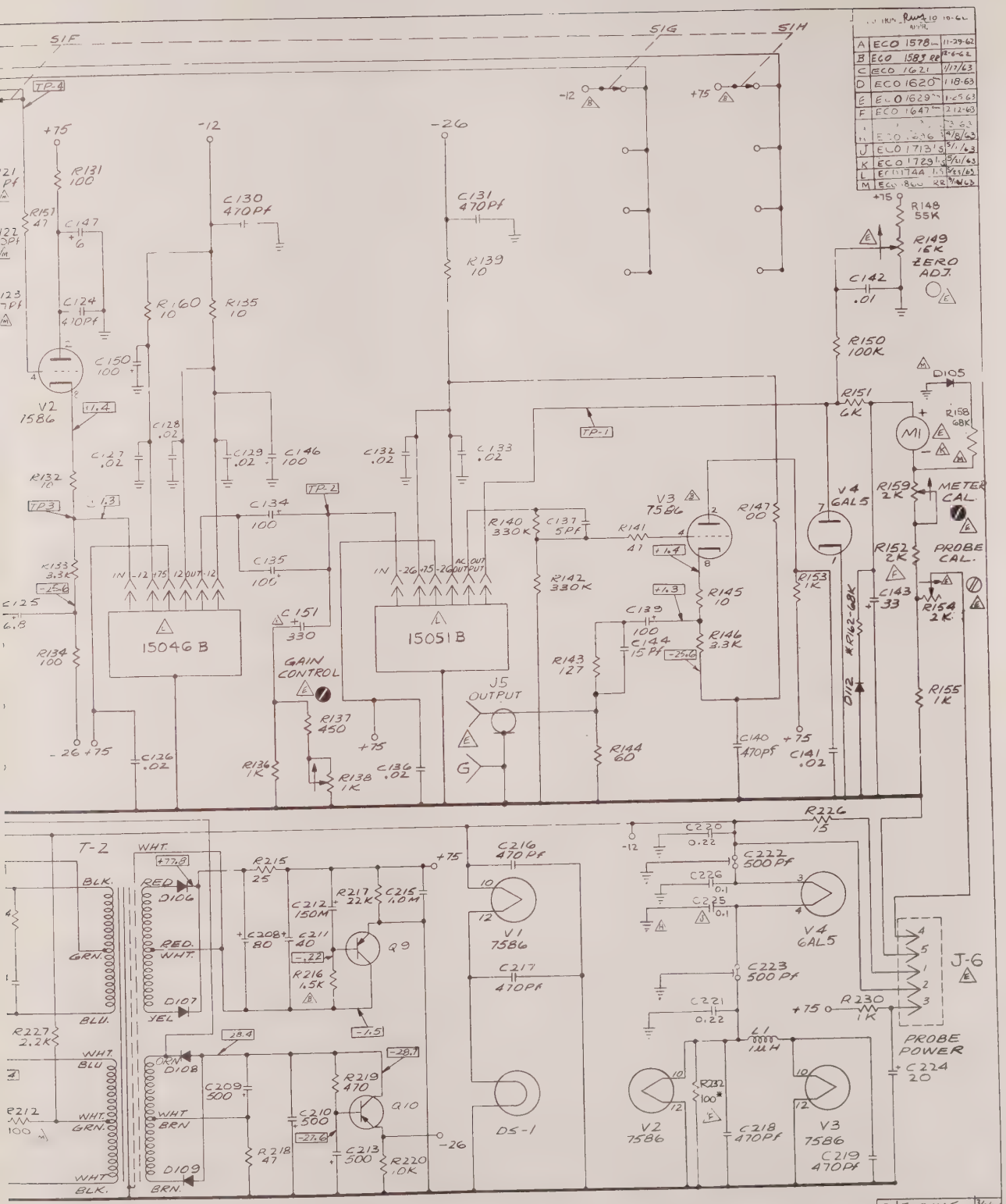
TITLE: SCHEMATIC, TWO STAGE AC AMPLIFIER

KEITHLEY INSTRUMENTS, INC. CLEVELAND, OHIO

DRAWN M. FURST DATE 5/17/62
CHECKED DTC DATE 6-8-62
APPROVED [illegible] DATE 9-19-62

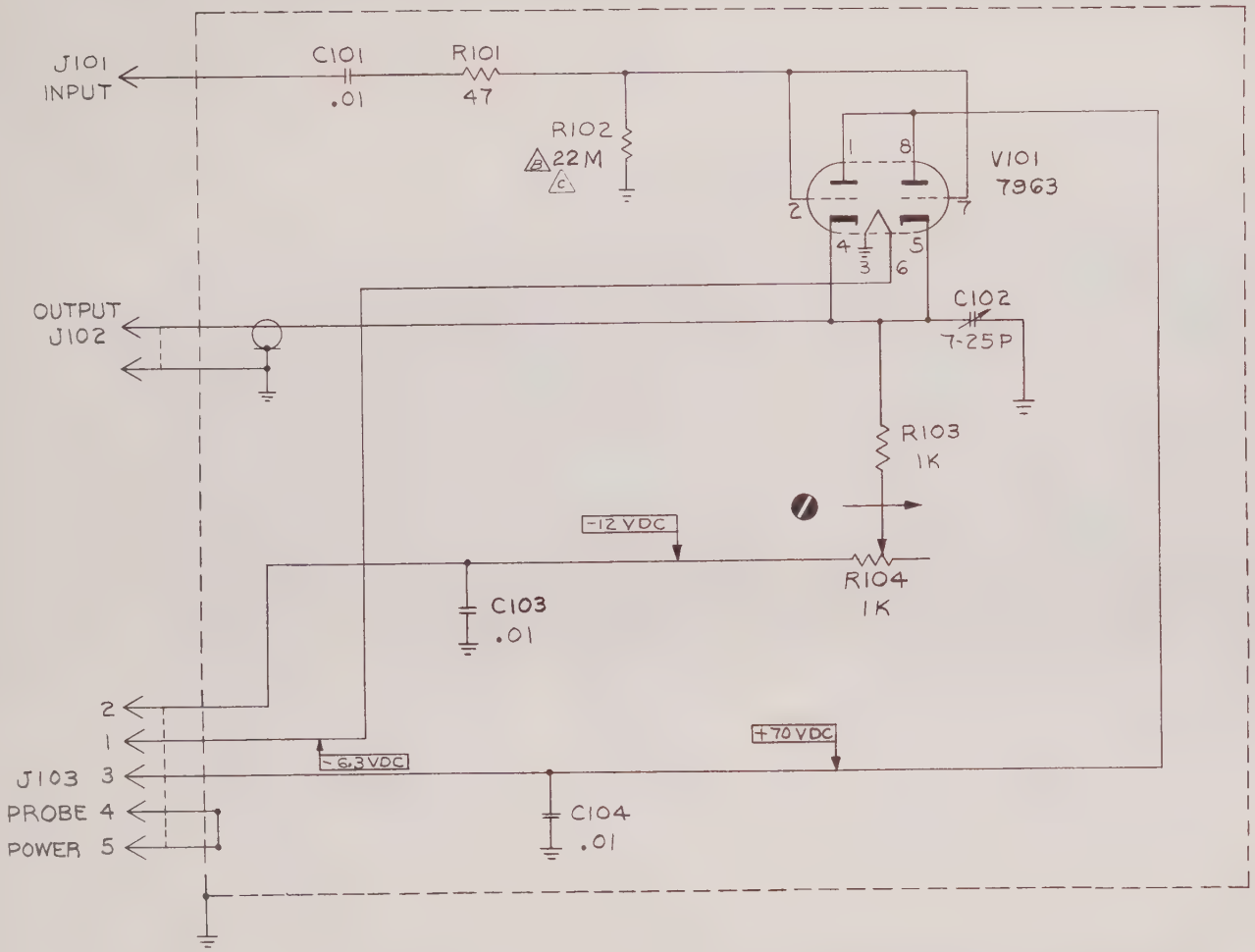
DRAWING NUMBER 150966


S1A
S1B
S1C
S1D
S1E
INPUT
C101
.01M
1MV
P2
J1
3MV
G
10MV
30MV
100MV
300MV
1V
3V
10V
30V
100V
300V
C157
.8PF
R101
990K
R102
10.1K
R130
68*
C102
4.5-25PF
C156
10PF
C103
3.3PF
R103
850K
R107
50K
C105
4.5-7PF
C104
2.2PF
R104
952.6K
R108
41.94K
R156
15*
C154
15PF
C106
4.25PF
C152
.75PF
R105
985K
R109
15*
R110
15K
C153
47PF
C107
4.5-25PF
C155
.3PF
R106
995.3K
R111
15*
C138*
75PF
R112
4.722K
C108
4.5-25PF
TP-9
TP-10
TP-11
TP-12
R115
12K
C109
470PF
C149
20
R114
220
V1
7586
R116
10
R113
1M
C115
.02
C111
.02
C112
.02
C113
.02
C116
100
C117
100
C145
100
R161
10
R119
10
C148
100
+1.2
+1.0
TP-5
R117
1.5K
C110
6.8
-14.4
15046B
IN -12
+75-12
OUT -12
R118
100
R120
300
R122
300
R121
1K
GAIN CONTROL
C114
470PF
C118
3-12 PF
R123
6.836K
C119
3-12 PF
R124
3K
C120
4.5-3PF
R125
9.684K
R126
10K
R127
3.162K
R128
1K
R129
3.162K
TP-6
TP-7
TP-8
R201
27K
C201
40
-24
-17.0
D111
D101
D102
D103
RED
GRN.
BLK.
BLK-WHT.
BRN.
BRN-WHT.
GRN-WHT.
117V
234V
117V
T-1
+1.0
F-1
.75A @117 VOLT
.38A @234 V.
S2
WHT
BLK
P1
GRN
C202
500
C203
500
R202
0.5
R203
560
R204
10K
R205
10K
R206
300
R207
10K
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
-12.0
-20.2
-13.5
-3.5
-10.2
-10.0
-9.0
-9.2
-9.5
-13.2
C204
100PF
D104
D110
R208
4.7K
R224
34K
R228
3K
10V
J2
10V
R223
19.5K
CAL SIGNAL ADJUST
J3
10MV
R222
20
J4
GND
R229
2K
C227
.0005
C205
1.2
12 VOLT ADJ.
R231
200
R210
600
R225
200
C206
.1000
R221
1.0
C207
.100
+1.37
-1.37
C214
NOTES:
1. * INDICATES NOMINAL VALUE ADJUSTED AT FACTORY
2. ALL RESISTANCE & CAPACITANCE SHALL BE DESIGNATED IN OHMS & MICROFARADS RESPECTIVELY. UNLESS OTHERWISE NOTED.
K-1000 OHMS M-MEG OHMS
pf-PICOFARADS CW ROTATION
FRONT PANEL CONTROL
FRONT PANEL SCREWDRIVER ADJ.
REAR PANEL SCREWDRIVER ADJ.
INTERNAL SCREWDRIVER ADJ.
3) TEST POINTS (T.P.) ARE SHOWN AT K
POSITIONS. REFER TO INSTRUCTIO
MANUAL FOR PARTICULAR VALUES.



4) DC VOLTAGES SHOWN HAVE BEEN MEASURED WITH A GROUNDED INPUT ON THE 30MV RANGE USING A VOM OF 20,000 OHM/VOLT SENSITIVITY. VARIATION OF ±10% IS PERMISSIBLE.

HIGHEST REFERENCE DESIGNATION					
R162	C158	V4	D112	M-1	J6
R231	C227	L-1	Q-10	Q5-1	V4
REFERENCE DESIGNATION NOT USED		T2	S2	E-1	P1



NOTES:
1. ALL RESISTANCE & CAPACITANCE SHALL BE DESIGNATED IN OHMS & MICROFARADS RESPECTIVELY UNLESS OTHERWISE NOTED.
2. ↑ CLOCKWISE ROTATION.
3. ⊘ INDICATES INTERNAL SCREWDRIVER ADJ.
4. * INDICATES NOMINAL VALUE.
5. K=1000 M=10^6 P= PICOFARADS

REVISIONS			
LTR	ECO No	APPR	DATE
A	REDRAWN		9/25/63
B	2065		11/6/63
C	2110		5/31/64

HIGHEST REF. DESIG. USED								REF. DESIG. NOT USED			
R104	C104	V101	J103								

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AS AUTHORIZED BY THE COMPANY

MODEL	NEXT ASSEMBLY	QUAN.
USED ON		
120		

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRAC.	DEC.	ANG.
± 1/64	± .005	± 1°
—	—	—
DO NOT SCALE		

DRN	I. S.	DATE 8/25/63
CKD.	M.F.	DATE 9/26/63
ENG APPR.		DATE 8-28-63
PILOT RELEASE		DATE 9/29/63
PROD RELEASE		DATE

KEITHLEY INSTRUMENTS
CLEVELAND, OHIO

TITLE: SCHEMATIC CATHODE FOLLOWER PROBE

MATERIAL

FINISH

PART NUMBER: 15483C

WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace any instrument or part thereof (except tubes and batteries) which, within a year after shipment, proves defective upon examination. We will pay domestic surface freight costs.

To exercise this warranty, call your local field representative or the plant directly, DDD 216-795-2666. You will be given assistance and shipping instructions.

REPAIRS AND RECALIBRATION

Keithley Instruments maintains a complete repair service and standards laboratory in Cleveland, and has authorized field repair facilities in Los Angeles and Albuquerque.

To insure prompt repair or recalibration service, please contact your local field representative, or the plant directly, before returning the instrument.

Estimates for repairs, normal recalibrations, and calibrations traceable to the National Bureau of Standards are available upon request.

CHANGE NOTICE

July 30, 1964 MODELS 120, 120R WIDEBAND VOLTMETER

Page 6-4:

Change D104 to:

D104	Silicon	1N645	01295	RF-14
D111	Zener	1N713	12954	DZ-2

Page 6-5:

Change R112 to:

R112	4.722 kΩ	0.5%, 1/2 w	MtF	75042	R61-4.722K

Page 6-11:

Change R2 (Model 1201) to:

R2	15 MΩ	10%, 1/4 w	Comp	01121	R76-15M

Schematic Diagram 15483C:

Change the value of R102 to 15 MΩ.

KEITHLEY INSTRUMENTS, INC.
12415 EUCLID AVENUE
CLEVELAND, OHIO 44106